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INSTRUMENTS

INDUSTRIAL — SCIENTIFIC

Devoted to the Instrument Problems of all Industries

Vol. 1. No. 8 Pittsburgh, Pa. August, 1928

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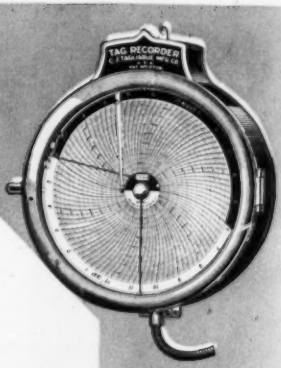

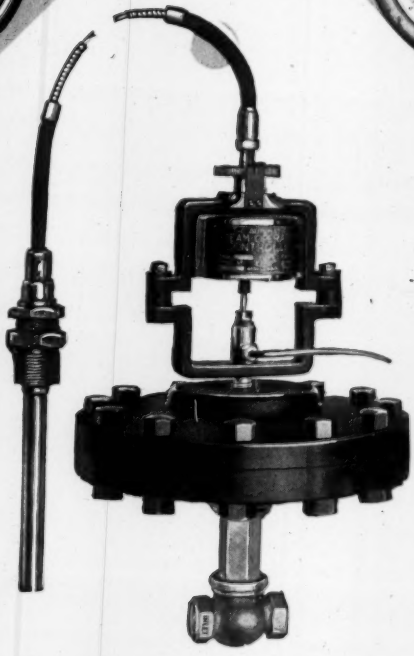

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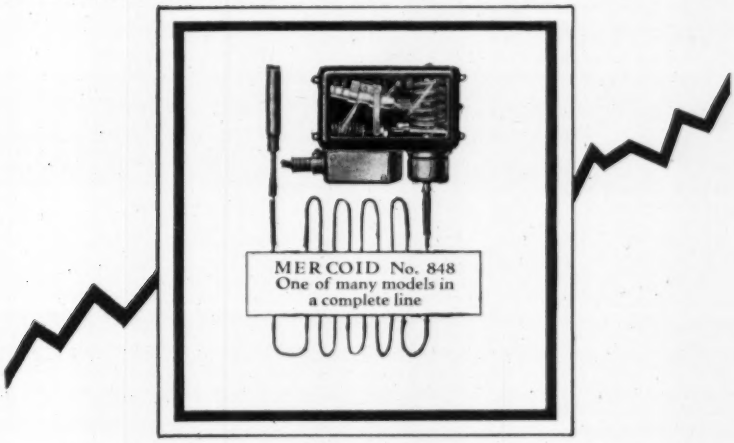

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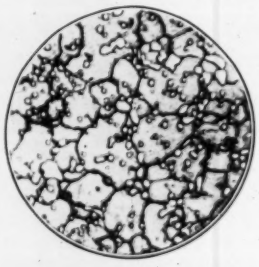

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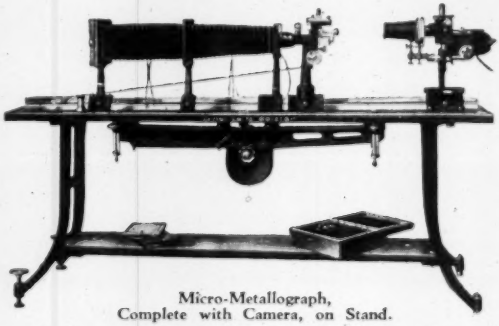

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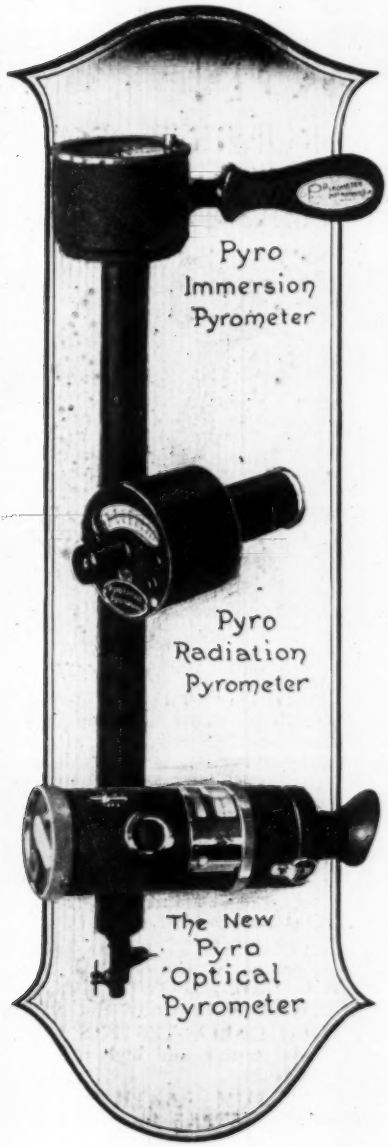

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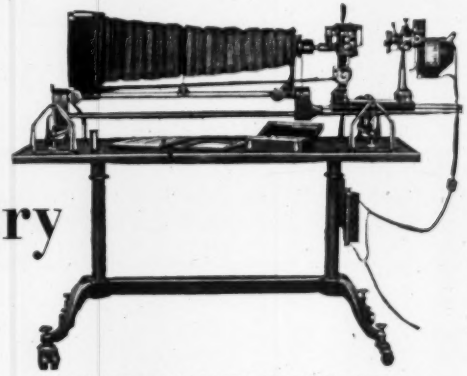

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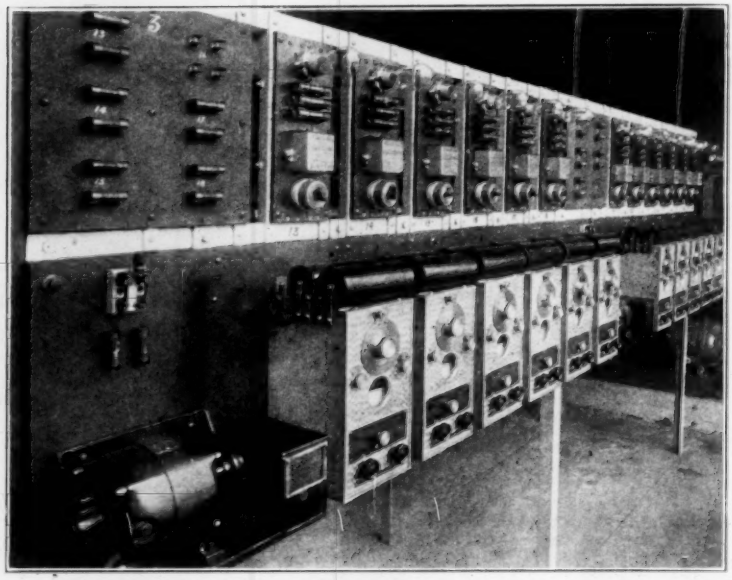
Have your stenographer cut out and file the 3 x 5 cards found bound in the back of this issue, listing the principal articles. They will direct you to valuable information to which you may wish to refer in the future.



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12 were ordered March 9, 1927

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INSTRUMENTS

INDUSTRIAL — SCIENTIFIC

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Vol. 1 No. 8. AUGUST 1928 Pittsburgh, Pa.

To Our Readers

THE editor has monthly taken up in a message to Instruments' Readers the various departments of the periodical pointing out the distinctive advantages. Last month a new department was organized and called the Instruments Book Shelf. This month we have the pleasure of announcing the extension of this service. Chapman and Hall, Publishers, recognizing the excellent work of Instruments in the short space of six months have appointed the Instruments Book Shelf as their sole American agent for their new book, "The Measurement of Air Flow."

Books are instruments in the hands of those using them and should be constructed to fill a specific need just as is the case with instruments. They should discuss the topics with which the book is concerned with sufficient fullness so that the data can be used. All practical methods of testing and measurement should be listed and their limitations, advantages, and disadvantages, if not discussed, at least tabulated. Tabulation permits of rapid survey of a large field, it stimulates analysis and comparison.

Books on instruments should be written so that the student will refer to them after his education is completed. They should be arranged so that it is not necessary to refer to and read earlier chapters to discover the meaning of the factors of equations.

———— :: ————

Co-operative Advertising

LAST month the editor briefly mentioned the possible value of co-operative advertising to the instrument industry. There is much to be done along this line.

Our industrial development makes it increasingly imperative that we readjust our advertising and selling methods so that instruments will be used more extensively and to greater advantage.

With an industry as diversified as the instrument industry, it is very difficult to bring about a general appreciation of the necessity for effective unified action. The editor is convinced, however, that in order to increase the use of instruments in industry, it is absolutely necessary to carry through adequate publicity and advertising.

At the present time there are more than 80 industries carrying forward promotional efforts on a co-operative basis. These many groups range from makers of disc wheels to growers of bananas.

In by far the majority of cases, this co-operative activity has proven highly beneficial and profitable. How much return might be expected from a co-operative instrument advertising campaign is impossible to answer, since we are not buying a tangible but rather an intangible something—with no assurance whatever that our efforts will be successful.

Yesterday's advertising policies do not meet with the same success as formerly—buying thought and purchasing power have changed since yesterday. By the same token they will be still further changed tomorrow. Increased demand cannot be gained today by hesitant coaxing. It must be sought aggressively and with a well directed effort.

Just one final word regarding this most necessary sales promotion effort—the true and lasting results to advertising are cumulative, not spontaneous.

———— :: ————

Instrument Investments

THE purchase of instruments for measurement, control and inspection is not as most people believe an investment. Instruments are a necessity to conserve, and operate efficiently.

Investment—when buying an instrument—is the difference in cost between the lowest price at which that type instrument can be purchased and the price which is actually paid. For example: if the purchasing agent writes to a number of instrument manufacturers for prices on pyrometers and prices are received ranging from $40.00 to $160.00. If you decide to purchase the cheapest there is really no investment because you must spend the minimum. If you purchase a pyrometer for $60.00 you are investing $20.00, for $80.00 you are investing $40.00 and so on.

You depend upon this investment for better results as a consequence of greater accuracy, greater sensitivity, greater sturdiness, better operation, less service to keep in satisfactory operation, longer life, etc. Thus if the $80.00 instrument will bring about a saving of the same amount as the $40.00 pyrometer and will take less repairing and will operate satisfactorily for longer periods, it is probable that the $40.00 investment is worth while.

Do not be afraid to pay a higher price for a thing that is better.

———— :: ————

Broadening the Markets for Industrial Instruments

AS manufacturing becomes more and more complicated, it must more and more resort to instruments for measurement, inspection and control. Some people state there are thousands of applications of instruments in industry. The fact is that there are millions of cases in

which instruments can be used; no two of which are exactly alike. It is impossible to suit the million applications and designers and manufacturers of instruments should therefore plan their instruments so that they can be used for a wide variety of the applications which are almost identical.

In too many cases instrument companies have unnecessarily restricted their markets to particular applications and industries. With minor changes of almost negligible cost, their products could have much wider sales possibilities.

Our New Collaborators

THREE new names have been added to our lists of collaborators. This is in line with our policy to add to the editor's advisers men who are specialists in their field.

R. V. Baud, Research Engineer, Research Laboratory, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

H. L. Hazeltine, Chief Engineer, Sterling Varnish Company, Pittsburgh, Pa.

Dr. Foster D. Snell, Consulting Chemist, Honorary Secretary of the American Section of the Society of Chemical Industry, author of a book on colorimetry, New York, N. Y.

Errata: A Simple Optical Arrangement for Photo-Elastic Experiments

THREE typographical errors were made in this article which appeared in the July issue. In Fig. 1 the light ray leaving surface K_2 should have been marked I_2. In Fig. 4 instead of $K = \lambda_1$ this should read $R = \lambda_1$. On page 308, seventh line from the bottom instead of $p - q$ this should read $p = q$.

1853-1928

On this, our 75th Anniversary, it is fitting that we should pay tribute to the two men whose foresight and industry have made possible this institution—an enduring monument to their perseverence and the progress of optical science.

To the friends whose confidence and patronage have made possible our success, we extend our cordial appreciation.

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WE extend our hearty congratulations to the Bausch & Lomb Optical Company in honoring the two founders of their company.

The motto of this company "To Greater Vision through Optical Science" conveys the purpose of this company's extensive activities.—May they continue to serve humanity for all time.

Back Issues Not Available

REQUESTS are received daily for back issues of INSTRUMENTS and we are sorry that it is not possible for us to comply with these requests.

In answer to our appeals for the return of copies of this issue we have to-date received so few copies that there are still over three hundred requests we cannot fill.

———— :: ————

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The Geodetic Level Rod—Its Design and Methods of Construction

*D. L. Parkhurst, Washington, D. C.**

IN geodetic surveying, where differences in elevation must be determined with the utmost practical precision, ordinary leveling apparatus is insufficiently accurate.

The outfit commonly used by engineers in running an ordinary line is the Y level in conjunction with the Philadelphia type of rod. The level is usually made of brass, which has a high temperature coefficient of expansion. The bubble vial is seldom more accurate than 10 seconds of arc per 0.1 inch graduation and the rod is made of wood with printed divisions. The accuracy obtainable with this apparatus is sufficient for all ordinary purposes; but for geodetic leveling, where the lines are extended for great distances and the probable accidental error must not exceed plus or minus 1 mm. per kilometer, special equipment is necessary and the construction of a rod suitable for this purpose has presented some interesting problems.

The rod, shown in Fig. 1, consists of a graduated metallic strip, rigidly attached to a metal footpiece, the later being fastened to a wooden backing which supports the strip.

The wooden part is 1⅛ inches thick by 3⅛ inches wide, the overall length being 10 feet 8¼ inches.

For leveling the rod, a spherical bubble is mounted on a step on the back of the rod, as far down as possible so that the line of sight is nearly vertical, and in order further to eliminate parallax, the reference circle is placed on the underside of the glass which forms the top of the level vial. The rods are used in pairs as forward and back sights are made from the level station and care is exercised in selecting them so that their coefficients of expansion and correction indices are practically identical.

In order to reduce the effect of temperature changes the graduated strip, about 3.3 meters in length, is made of invar, a nickel-iron alloy having a temperature coefficient of about 0.000002 per degree centigrade, which is approximately one-fifth that of iron. In other words, a temperature change of 50° F. would cause a difference of only eight one-thousandths of an inch in the entire length of the strip. This small amount is corrected for by computation, thermometer readings of the temperature being taken while the rod is in use.

The invar strip A, referred to above, is fastened to a cast-steel footpiece B by a brass machine screw and 3 bronze dowel pins. The strip is 26 mm. wide and 1 mm. thick. The lower surface of the footpiece is casehardened and ground flat and normal to the surface against which the wooden back C is fastened and which is also ground flat.

*Chief, Instrument Division, U. S. Coast and Geodetic Survey.

The back is made of a single piece of well-seasoned, straight-grained white or sugar pine, free from knots or other defects. This wood was chosen as being one of the lightest and stiffest and reasonably free from tendency to warp. This is securely fastened to the footpiece by four brass screws in the face and two more at the end. The face of the rod is concave, the recessed part being ¼ inch below the edges. In addition, a shallow groove, slightly wider than the invar strip is routed out through the entire length at the bottom of the concavity deep enough so that the strip is free to move underneath a number of brass washers cut in to set flush with the face. A handle for convenience in carrying is attached to the back, near the center of gravity.

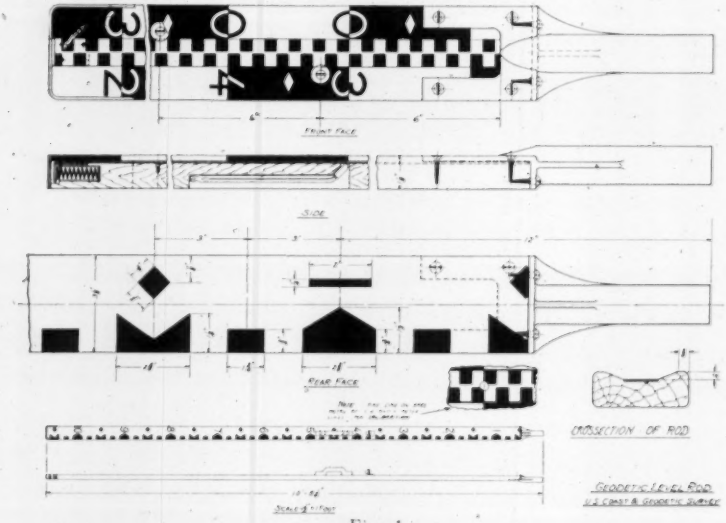

Fig. 1

To prevent swelling; the wooden back is treated with a heavy coat of raw linseed oil, three coats of orange shellac, and two coats of white lead paint. This treatment furnishes an excellent protection against moisture and does not affect the resilience of the wood.

The thermometer used for determining the temperature of the strip is graduated to ½° C. and is of special construction, with a fine capillary and having the bulb bent backward at 45°. This is set in a recess in the wood, the bulb resting against the rear surface of the invar strip.

In order to eliminate any error which might occur due to sagging when the rod is held erect, the strip is placed under tension by a stiff spring set into a recess in the back and pressing against a small brass angle plate attached to the top of the strip.

The graduations are in the form of alternate squares of black and white painted on the invar strip. As metric units are used the squares are 1 cm. in width. To furnish a check on the observations the rear surface of the wooden back is graduated roughly in 30th parts of a meter. Both sides of the rod are read and recorded at each station,

thus eliminating the occasional gross error caused by an incorrect reading which might remain undetected if a compensating error of similar magnitude were made on the opposite running of the section.

The graduations were formerly applied by coating the strip with white paint, then placing it beside a master scale and transferring the dimensions by means of a steel square and scriber. The black squares were then filled in by hand, a most tedious process. With this method it was impossible to obtain uniformity of width, as the scriber cut a shallow groove of finite width, causing a general tendency for the black squares to be wider than the white. Irregularity of the lines of demarcation was also unavoidable. A graduating machine has been designed and built by the Survey to do this work with greater accuracy and speed.

In the present method, the invar is given a suitable priming coat and then sprayed with several coats of white pyroxylin lacquer, rubbed down between coats. This finish is very tough and shows little tendency to spall off even when badly cut or bruised.

The graduating machine (Fig. 2) is based upon the comparison method, thereby avoiding the necessity for cutting a long and accurate lead screw and for working at constant temperature. An invar bar of the same physical characteristics as the strip, accurately ruled in 1 cm. spaces, is located in a groove at the rear of the machine. A microscope is mounted on the carriage having a pair of fine parallel tungsten wires in its focal plane. Small electric bulbs placed beside the microscope tube shine down upon the comparator bar causing the ruled lines to stand out brilliantly. The tungsten wires show as intensely black lines against this brilliant background, and the setting of the carriage is surprisingly easy.

The cross slide of the carriage carries a vertical element on which is mounted a cup-shaped turreting mask having four rectangular slots 1 cm. wide cut in its rim. The turret is lowered and pressed against the work by a small eccentric, and the open space is sprayed with a quick-drying black paint by means of a small air brush. As the mask is raised vertically no difficulty is experienced with smearing the paint, and it is not necessary to wait until it dries. As soon as a square has been painted the mask is raised and the carriage traversed to the next space and the process repeated.

The multiplicity of openings is desirable to facilitate the cleaning away of paint accumulating along the edges of the mask, without delay to the work.

The resulting graduations, both white and black, are all of the same width. The lines of demarcation are straight and sharp, and the sharpness is enhanced by the thinness of the film of black, which does not provide a raised and shining surface to cause annoying reflections.

In the former process the initial meter line was laid off roughly 1 m. from the foot, a scratch line being made on the metal of the strip at this point, the actual distance being carefully measured later. This

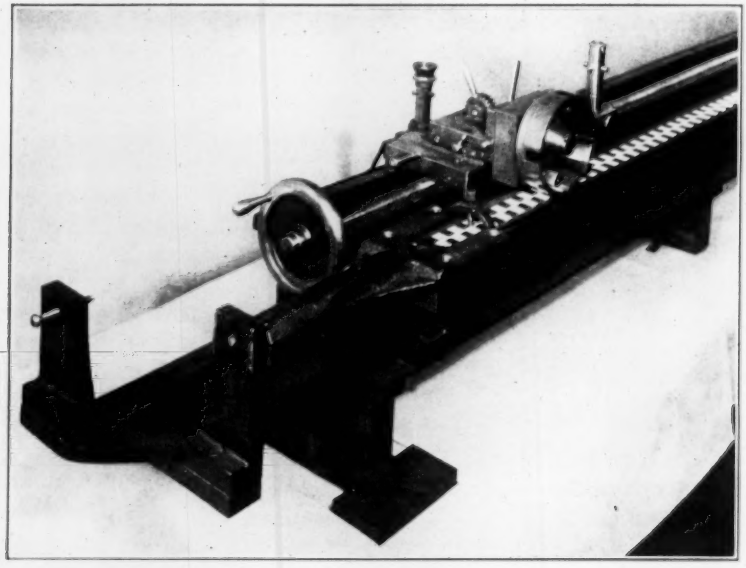

Fig. 2

gave an odd figure for the index correction to be used in computation. To remedy this, stops for the strip and comparator bar have been provided at the end of the machine, so adjusted that when the strip, with its footpiece, is placed in position the 1 m. graduation of the bar is exactly 1 m. from the lower end of the footpiece.

The line is transferred from the bar to the strip by means of a scriber and a sort of tee square of cast iron which slides in a Vee-groove in the machine bed. A microscope similar to that on the carriage is mounted on the blade of the square, so that the lines on the reference bar may be observed through it. A short straightedge at the other end, over the strip, serves as a guide for the scriber. The meter space may thus be readily transferred.

To facilitate the setting of the machine, a small additional microscope is mounted rigidly on the vertical slide. It carries a single wire in its reticule, which is adjustable. When properly set, this wire is an exact number of inches from the edge of the slot in the mask, consequently, when it is located directly over one of the meter lines previously ruled on the invar strip, the machine is in the proper position to commence work.

The use of this machine has greatly speeded up the work of applying the checker work graduations as well as insuring their accuracy, and it is now possible to graduate a complete rod in about three hours, whereas, by hand it took from one to two days. The spacing is far more accurate and the edges of the squares are sharp and straight. These factors will increase the accuracy and speed of leveling and the fact that all rods are practically alike will greatly facilitate the work of computation.

Measurement of Temperatures In Boiler Furnaces

J. A. Stein, Pittsburgh, Pa.

THE need for a practical, accurate method of measuring boiler furnace temperatures is often felt and the view is held in some quarters that this would be one of the more important temperature measurements in the boiler house. Not only does this provide a means of preventing damage to furnace refractories, stoker parts, etc., but such measurements also are usually a good guide as to combustion efficiency. On boiler tests furnace temperatures especially are quite important. Such temperature measurements are possible of attainment and an effort will be made here to show how these measurements may be most feasibly accomplished:

There are a number of types of pyrometric devices available for the measurement of high temperatures, which include thermocouples, optical pyrometers and radiation pyrometers. Let us briefly consider the applicability of these various devices to the measurement of boiler furnace temperatures, where the temperatures may go as high as 3000° F. and in exceptional cases, higher.

Considering the rare metal thermocouple for this application, we may say it is, of course, accurate and furnishes continuous readings which may be recorded. Such readings would be a measure of both flame temperature and refractory temperature to a certain extent. However, rare metal thermocouples prove unsatisfactory for this application due to the necessarily short life of the protection tube in which the thermocouple must be encased. No protection tube known will withstand these higher furnace temperatures for any length of time especially when considering the erosive action of molten slag from the furnace walls. Deterioration of the thermocouple protection tube usually necessitates reconditioning or replacing the expensive thermocouple elements.

In the optical pyrometer, we have a device to some degree more suitable. It is, however, strictly a portable instrument and requires a practiced operator, on whose skill the accuracy of the readings depends. Using this instrument, the intensity of a glowing lamp filament is matched with the intensity of the object or field sighted through the optical pyrometer telescope. Flame temperatures may be approximated if opaque luminous flames are sighted upon, provided that no considerable smoky condition is prevalent in the field of vision. However, since flame temperatures constantly fluctuate in intensity, much faster than it is possible to adjust the filament intensity of the instrument, it is usually impossible to obtain better than an average reading between high and low flame temperature fluctuations. If the flames depart appreciably from the opaque condition the optical

pyrometer cannot be used to measure these flame temperatures. Under some conditions, boiler furnace atmospheres may closely approach clearness. In such cases the optical pyrometer can be used to measure the temperature of the opposite walls.

This now brings us to the radiation pyrometer, which has in recent years been developed very highly. Such instruments measure the temperature of a glowing surface, such as opaque flame or refractory walls, by converging the radiated energy emitted by such surfaces on one or more small thermocouples or bimetallic thermostat. The small thermoelements quickly heat up (in a few seconds) and the millivoltage developed by these thermocouples or the deflection of the thermostat is a direct measurement of the desired temperature, under proper conditions.

In measuring opaque flame temperatures with a radiation pyrometer, it is necessary to see that no appreciable smoke is present in the field of vision. The instrument reads continuously, integrating the temperature of a considerable flame area, and would constantly follow the varying flame temperature. If the flames are of a translucent or transparent nature, the radiation pyrometer reading would be an average between the actual flame temperature and the temperature of the opposite wall. If the boiler furnace atmosphere approaches clearness, the radiation pyrometer, like the optical pyrometer, will read the temperature of the furnace walls in the field of vision of the instrument. Such refractory temperatures are to some extent a measure of flame temperature except in the case of certain water cooled wall construction.

Radiation pyrometers are available in either portable form or for permanent installation. The portable pyrometer can be mounted on a tripod or held in the hands of the user, and should be sighted into the boiler furnace through an opening in the furnace setting. If no inspection doors or other openings are located at the points where temperature measurements are desired, it would then be necessary to make a small hole in the setting, through which the instrument can be sighted.

The radiation pyrometer for permanent installation is made up of two separate parts, namely, the radiation pyrometer itself, or as it is termed, the radiation set, and the millivoltmeter, calibrated in degrees Fahrenheit or Centigrade. The radiation set should be mounted on the outside of the boiler furnace setting and sighted directly into the furnace through a small sighting hole. Any effect on the furnace operation of having this open sighting hole (not more than 2 inches in diameter) will be negligible. The radiation set is installed in a metal housing, for protection both against mechanical injury and excessive heat. The millivoltmeter, which may be indicating or recording, can be located wherever desired, any reasonable distance from the radiation set.

It should be mentioned that sometimes in place of the open hole in the boiler furnace setting, a closed end glowing tube is fixed in the furnace wall, extending into the combustion chamber. The radiation pyrometer is then sighted into the closed end of this tube, which, of course, is a measurement of the furnace temperature. However, the use of such a closed end tube will cause a slight error, unless a very long tube is used, and introduces a time lag factor, which will vary with the material and thickness of the glowing tube. Also, of course, these glowing tubes will require replacement from time to time due to the high temperatures and erosive slag action.

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SNOW DENSITY

Measurements of the density of snow in the Sierra Nevada Mountains of California have been made every winter for many years for the purpose of determining the water content, thus indicating the probable amount of water available for irrigation and hydroelectric power during the following dry season of summer. These density measurements of the snow cover by foot layers made during five consecutive years at Summit, California, altitude 7,017 feet, indicate that there is a lack of uniformity in density in different layers of deep snow, due to changing weather conditions during the accumulation of the snow cover. In the intervals between storms, icy crusts of varying thickness and density are invariably formed. The density of lower layers bears no constant relation to the density of the top layer. The average density for the whole snow cover for the five years ranged from 32% in midwinter to 54% in May.—Tycos-Rochester.

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The Paulin System is covered by patents in all civilized countries.

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Mr. R. D. Kelly of the Instrument Section of the Army Air Corps, Dayton, Ohio, assumed charge Aug. 1st, of the Aeronautical Instrument Department of The American Paulin System, Inc., Los Angeles, Calif.

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Instruments for the Solution of Triangles and other Polygons

*Joseph Eugene Rowe, Ph.D., Williamsburg, Va.**

THE U. S. Patent Office under the date of Feb. 28, 1928, issued two sets of letters patent Nos. 1661095 and 1661096 upon instruments for the mechanical solution of triangles and other polygons.

The possible application of these instruments to problems in everyday life may be briefly summarized as follows:

(1) To simplify computations in surveying.

(2) To be the basis of a set of automatic surveying instruments.

(3) To be applied both directly and indirectly as range-finders in artillery on land and at sea.

(4) To have constructed upon these as a basis instruments for locating the position of a ship at sea or of aircraft, AND TO ENABLE AN AIRCRAFT TO LOCATE ITSELF.

(5) To aid in teaching mathematics in such a way as to humanize and practicalize this subject.

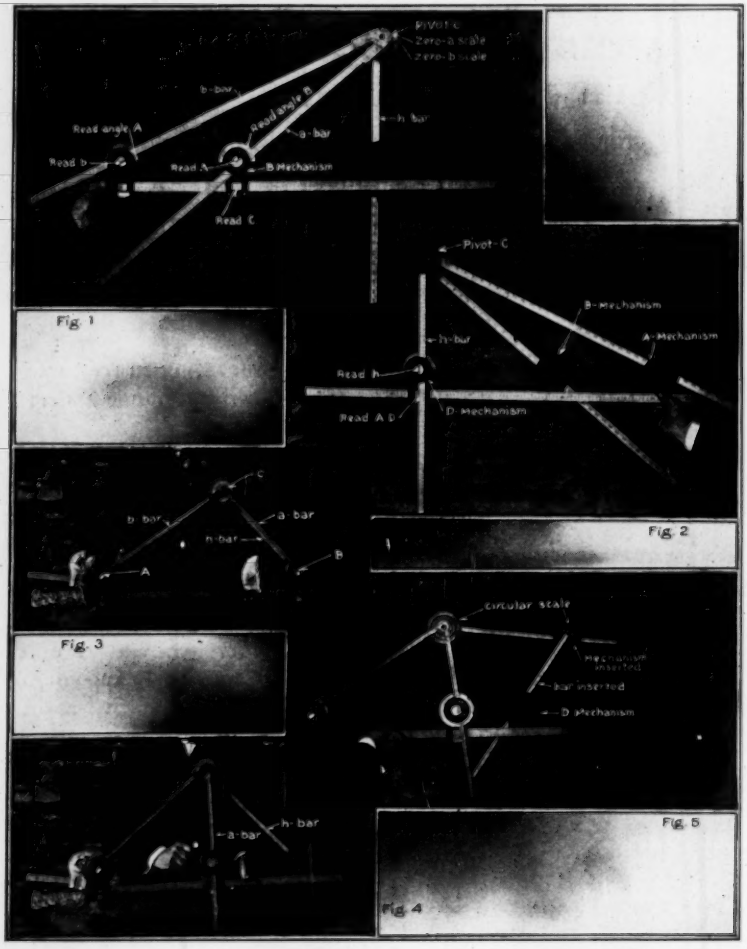
The Trinometer, the instrument which solves triangles mechanically and simplifies the finding of their areas, is nothing more than a triangle whose parts may be fixed at given values; when a set of determining parts are given, the triangle is fixed and the unknown parts may be read from the instrument. Its operation is simplicity itself, it involves no knowledge of logarithms and no knowledge of trigonometry; the fundamental principle involved is that of similar triangles.

In each of the simple instruments shown in the photographs, the triangle to be solved is ABC. In these instruments, the two angles A and B are read directly from circular scales and the lengths a, b, c, AD, and h are (at the points indicated) read directly from straightway scales. The third angle is found as the supplement of the other two. These are called plain-scale trinometers because no verniers are used in reading the circular or straightway scales. However, such finer readings are amply provided for in the patent specifications.

The accuracy of the instrument depends entirely upon the quality of workmanship employed in its construction. Instruments may be made to solve triangles as accurately as is required in ordinary problems. In fact, the matter of accuracy in solution is one of accurately reading what the instrument says rather than one of accurate functioning of the instrument. The instruments shown in the photographs have been designed to solve triangles correct to within 1%. In practice, they give much better results.

Instruments may be provided with locks which control both ro-

*Director, Extension Department, College of William and Mary.



tation and extension of the bars but in practice, except in unusual cases, it has been found unnecessary to provide for the locking of rotational movement separately as this can be accomplished by the locking or the lengthening of a bar.

The manipulation required to solve triangles is briefly summarized below, which description must be read with reference to the photographs.

SOLUTION OF TRIANGLES

1. Given two sides and the included angle. Slide bar b through its sleeve until one given side is recorded at the point marked "Read b," and lock this movement by screw. Slide the mechanism B along the base bar until the second given side is recorded at the point marked "Read c;" lock with screw.

Slide a through its sleeve on the mechanism B until the given angle is recorded at the point marked "Read angle A;" lock a or the angle A. Read a and angle B at the points marked. C=180°—A—B. Now slide D along the base bar until the angle ADC = 90°. Read the altitude h and AD at the points indicated. AREA = ½hc.

2. Given two angles and the included side. Lock the given side equal to c. Slide the arms a and b through their sleeves until the given angles are recorded as A and B. Lock these parts and read the unknown parts at the points indicated. Or, take the given side as b, a given angle as A, and the supplement of the angles as B. Lock, and read the unknown parts as indicated. Find area as in the last case. The second of these two methods is to be preferred.

3. Given three sides. Fix the three sides. Read the angles A and B. Find C as their supplement. Find area as above.

4. Given two sides and an angle opposite one of them. Fix the given angle as A, the adjacent side as b; push the mechanism B to the right until the opposite side is recorded as a; push the mechanism D to the left until the opposite side is recorded as h. Read the two solutions. Impossible solutions and one solution cases will appear by following this manipulation.

THE TRINOMETER PROBLEM. An engineer measures two angles of elevation of an object at points on a line with its base; then he measures the distance between them. To find the unknown parts is the Trinometer problem. Fix A = the smaller angle of elevation, c = the measured distance, and B = supplement of the larger angle of elevation. Slide D until the angle ADC = 90°. Read a, b, h, Ad, and BD as the required parts of the configuration. The triangle may be fixed also by the second method outlined under case 2.

To find 357 cos 30° 25′. Make b = 357, B = 90°, and A = 30°; read a and c as 357 sin 30° and 357 cos 30°. Do the same, making A = 31°; read a and c as 357 sin 31° and 357 cos 31° Interpolate to find 357 sin 30° 25′ and 357 cos 30° 25′.

To find 834 tan 38°. Make A = 38°, B = 90°, and c = 834; read a as the required quantity, and b as 834 sec 38°.

In Fig. 1 above the side c has been set equal to 300, the angle A has been made equal to 25°, the angle B made equal to 140° (that is, the angle of elevation of the a-bar is made equal to 40°). Thus, the triangle ABC is fixed and we may read the length AC (or b) at the point indicated, the length BC (or a) at the center of the mechanism B. See also Fig. 2.

In Fig. 2, we may read from the same setting the distance AD and the altitude h at the points indicated.

The finding of these four distances, having given a base line and two angles of elevation, is called "the Trinometer Problem." This form of the Trinometer is designed to be on a table, or desk.

In Fig. 3 is the design of a Trinometer to be held in the hand for classroom work in the rapid solution of triangles. The triangle has been set by fixing any three determining parts. Leaving the h-bar and b-bar fixed so that the triangle will be rigid, the mechanism B is moved as indicated in Fig. 4. If the a-bar is moved to a perpendicular position, the altitude of the triangle can be read at the center of the B-mechanism. Also, by moving the mechanism B to the proper position along the base-bar, the length of a median, or the length of a bisector of an angle can be read at the center of the mechanism B.

In Figure 5 we have a model showing how an additional bar and an additional mechanism can be inserted to form a tetranometer for the solution of quadrilaterals.

The Roller-Smith Company, 233 Broadway, New York, N. Y., announces the appointment of Mr. Elliott E. Van Cleef, 53 W. Jackson Boulevard, Chicago, Ill., as its District Sales Agent in the Chicago territory.

Mr. Michael B. Mathley, who has been connected with the Chicago office for many years will be associated with Mr. Van Cleef.

Contents of Subsequent Issues

Historical Sketches of Men who have contributed to the advancement of the Instrument Science.
Research of Instrument Literature.
The Calculagraph.
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The Measurement of High Temperature by Radiation Pyrometers.
Modern Precision Measuring Tools for Machine Shop Use.
Why Flyers Need Instruments.
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Mechanical Vibrations and Their Measurement.
Instruments to improve Diesel Engine Efficiency.
Comparison of Instruments for Measuring Hardness.

Design of Instrument Transformers**

*James S. Martin, Springfield, Ill.**

IN the discussion which is to follow it is not our intention to delve deeply into or to dwell at great length upon the purely technical side of the subject. On the other hand I cannot avoid entirely the technical considerations involved in the transformer. But in the development of this topic the one outstanding thought which I have had in mind is this: that here we are assembled together—professors of Electrical Engineering, practical meter men, some young in the game and others who can look back over many years spent in developing meter departments up to their present high standing—and as a third part in this group we have the manufacturers' representatives. Now whoever designs a transformer or a meter or a testing rack or perchance a new system for keeping the records in your departments, should keep in mind that whatever it is that is designed must be satisfactory to all of these groups which are represented here. The design first of all must be theoretically correct—how else can it satisfy the man who is interested primarily in the academic phase of the art? Again the design must be applicable. How else can it satisfy the man who eventually must use it? Again the design must be capable of being manufactured at a cost comparable with the importance of the device being designed. So in the development of this discussion of the subject of Instrument Transformer Design it has been my hope that somehow the discussion might bring us all a little closer together in our thinking, and in particular that you practical meter men as well as you who represent the technically trained staff of the industry might realize how fully the manufacturer appreciates both the theoretical and practical requirements in instrument design and to point out if I may, some of the ways in which we have attempted to meet these requirements.

Instrument transformers are primarily auxiliary devices used in connection with electric meters to bring about a practical solution of the problem of supplying adequate insulation and current carrying capacity of the electric circuits in the meter. In addition to the foregoing fundamental uses of instrument transformers might be mentioned also the use of instrument transformers as a means of promoting standardization of equipment. For example, the use of current transformers in order that all watthour meters, wattmeters, ammeters, et cetera, might have the same current rating in their series circuits—usually five amperes. Or again instrument transformers may be used to bring about some fictitious condition of voltage or current which when combined with a meter which normally measures one quantity will give rise to a registration

*Assistant Chief Engineer, Sangamo Electric Company.
**Lecture presented before fourth annual meter school at the Carnegie Institute of Technology.

which is proportional to some other measurable function of the circuit. A phase shifting transformer used in connection with kv-a. measurements would exemplify this latter application. Instrument transformers are also used in connection with the operation of devices other than electric meters, but their application in such fields will not be discussed in this paper.

More specifically in electric metering two classes of instrument transformers are commonly employed: Current or Series transformers and Voltage or Potential transformers. The essential parts of both voltage and current transformers are the same and are also the same as the parts of power transformers.

The function of an instrument transformer is to deliver to the electric meter to which it is connected a voltage or current, insulated from the line voltage, which is under all conditions of the circuits involved proportional to the primary voltage or current and for most metering requirements the secondary voltage or current must also be in phase with the primary voltage or current. The percentage by which the secondary voltage or current differs in magnitude from being exactly proportional

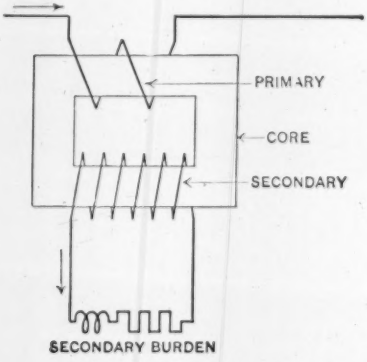

Fig. 1
Diagrammatical Sketch of Typical Current Transformer.

to the corresponding primary function is called the ratio error of the transformer. The angle by which the secondary voltage or current differs in phase from its primary counterpart is called the phase angle of the transformer. The effect of any given ratio error upon the accuracy of the metering installation is always the same. The effect of phase angles depends upon the phase displacement between the voltage and current in the supply circuit. The effect of instrument transformer phase angles is least for unity power factor loads and increases rapidly as the power factor is lowered. In general ratio errors which are inherent to the design of the transformer can for some particular condition of use be compensated for by making the actual ratio of turns in the windings slightly different from the theoretical ratio of the transformer. In some instances errors due to phase angles may also for one particular circuit condition be compensated for by changing the phase relation between

the fluxes in the voltage and current circuits of the watthour meter. It is readily seen that these two methods of compensating for ratio and phase angle errors are limited in application to cases in which the circuit conditions which influence the behavior of the transformer are constant. This condition is nearly realized in the use of potential transformers but with current transformers load conditions vary over wide limits and so the elimination of transformer error is a much more difficult problem.

Let us now make a somewhat more detailed study of the current transformer. Fig. 1 shows a diagrammatical sketch of a typical current transformer. Fig. 2 is the vector diagram of the ideal current transformer. In this case n is the ratio of turns and the primary current I_1 is exactly equal to nI_2 and exactly in phase with I_2 reversed.

Fig. 2

Practically the actual transformer is more nearly represented by the vector diagram shown in Fig. 3. Here the primary current represented by P consists of two component parts S′ and I. I represents the exciting current necessary to establish the flux Φ and the corresponding secondary

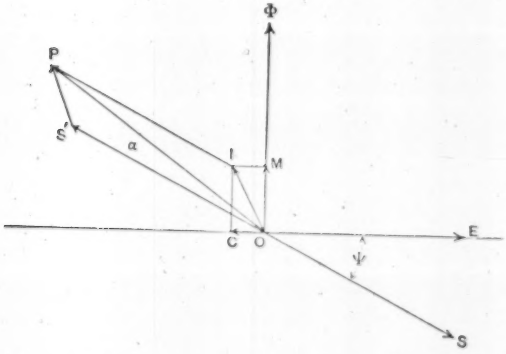

Fig. 3

Vector Ampere-turn Diagram for a Nominal One-to-one Ratio Current Transformer.

voltage E. S is the secondary current which lags behind E by a certain angle Ψ. This angle is determined by the power factor of the secondary burden on the transformer and by the resistance and leakage reactance of the secondary winding. The exciting current I is made up of two components. The first C is the core loss component while the second M is the magnetizing component. The value of I together with each of its component parts varies for every different condition of secondary load and of secondary load burden. In every case S′ which is the reversed secondary current will be the vector difference between the primary current P and the exciting current I and in general will not only differ from P in magnitude but will also have a certain phase difference indicated by α.

It is very apparent from this diagram that whatever errors of ratio

or phase angle exist can be charged to the effect of the exciting current I. This exciting current I in turn is not constant nor are its core loss and magnetizing components always in the same proportion since I, M and C all depend upon the value of the flux density in the core. This flux density is a function of (1) the frequency of the supply source, (2) the impedance and power factor of the burden connected to the secondary circuit and (3) the value of the current itself. Another possible cause of variation in the core flux density would be variations in wave form of the current flowing. This, however, can be shown both by calculation and actual test to be in general a negligible consideration.

Fig. 4 shows the ratio and phase angle curves of a typical transformer. Notice that both ratio and phase angle change for changing loads and that these changes are most rapid at the lighter loads where the exciting current forms a larger part of the primary current.

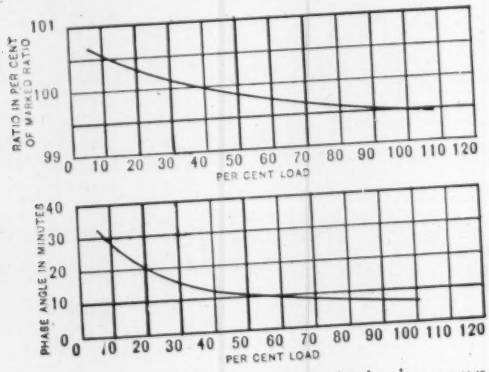

Fig. 4

Typical Ratio and Phase-angle Curves for a Current Transformer.

Fig. 5 shows the way in which the components of the exciting current vary with the load on the transformer.

Referring again to Fig. 3 it is quite readily seen that when the secondary burden is non-inductive or nearly so, the ratio of the transformer will be affected chiefly by the core loss component of the exciting cur-

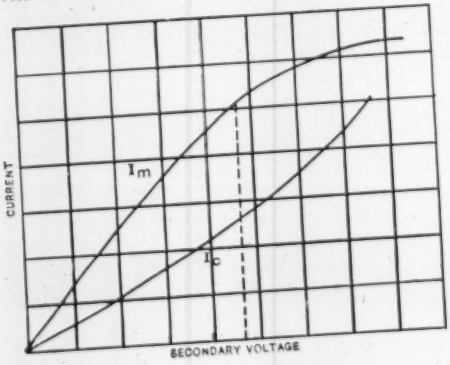

Fig. 5

Curves showing how Magnetizing and Core-loss Components of Exciting Current vary with the load for a given Secondary Burden.

rent and the phase angles will be largely dependent upon the magnetizing current. In fact it has been pointed out by many writers in this connection that for non-inductive secondary burdens the ratio and phase angle can be very closely represented by the formulæ

$$R = n + \frac{C}{I_2}$$

and $\tan \alpha = \frac{M}{n I_2}$. This means that the ratio tends to become equal to the number of turns as the current increases and that the phase angle becomes more nearly equal to zero as the current increases. Now instead of thinking of the core loss component of the magnetizing current, let us think of the core losses expressed in watts by the usual formula:

$W = K B^e$ where W is the total iron loss in watts, B the maximum flux density and e and K constants for a particular transformer at a given frequency. Under this condition for a non-inductive secondary burden it can be shown that the usual ratio curve occurs when e is less than 2 but that for a value of $e = 2$ the ratio curve would become a horizontal straight line. To fulfill this condition of $e = 2$ there must be either no hysteresis losses so that all of the iron losses are due to eddy currents which losses do vary with the square of the flux or else the hysteresis losses should also vary with the square of the flux density. Having now shown the condition for a straight ratio characteristic, it must be observed that this condition is extremely improbable since the assumption of hysteresis losses being expressed $W_h = B^2$ is not tenable when it is remembered that B varies over a range of from approximately 10 lines to 1200 lines, per sq. cm. in the usual current transformer and the so-called Steinmetz constant for hysteresis losses becomes a variable with a wide range of values.

For a more exhaustive treatment of the subject of the relation between iron losses and performance curves of current transformers I would refer you to a paper on this subject published in 1911 by Dr. P. G. Agnew then of the Bureau of Standards. A study of Dr. Agnew's paper will show that if certain conditions governing iron losses can be met, the perfect transformer will result, but on the other hand, to use a popular expression "try and do it." The point which I wish to emphasize is this: that in this case as in many other cases in design, ideal performance is predicated upon assumptions which are practically never realized. Nature and science together, bountiful as they have been, are still withholding from us materials and processes which we can describe but as yet have not seen or experienced.

Returning again to the practical problem of eliminating or at least reducing ratio and phase angle errors, four methods present themselves. The first to which I would direct your attention involves the number of ampere turns. Referring again to Fig. 3 we see that the exciting cur-

rent I, which we should remember is the chief disturbing influence in the transformer, depends in value upon the required secondary voltage E. Also the value of I depends upon the number of primary turns since the flux Φ is set up by a certain number of *ampere turns* and as the number of primary turns is increased the value of I for a given secondary voltage is decreased. However, as the number of secondary turns is increased, the secondary resistance and reactance also increase, thus increasing the required value of secondary voltage E for any certain load and burden. Without going into a more detailed discussion, it will probably suffice to say that in a one-stage transformer there is a certain number of ampere turns which will give best results. This number in the best grade of modern transformer varies from 1200 to 1800 ampere turns. At this point we see that in high tension metering requiring bushing type transformers, the number of ampere turns at full load is limited to the number of primary amperes so that for a 200 ampere bushing type transformer at full load there would be only 200 ampere turns and such a transformer would be certain to have rather bad characteristics.

The second method of reducing transformer errors consists in making the impedance of the transformer windings as low as possible. Assuming for the moment the secondary burden on the transformer to be zero, then with perfect coupling between primary and secondary windings and with zero resistance, the exciting current I would be reduced to

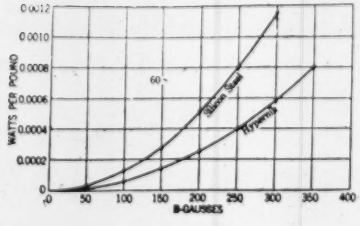

Fig. 6

Core Loss of Ring Punchings. Ring Dimensions = 5 7/8 in. by 3 3/8 in.

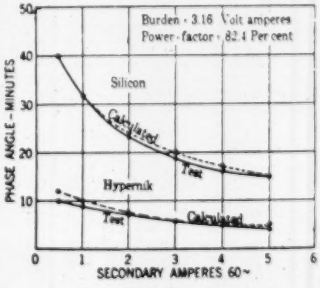

Fig. 7

500-5 Ring-Type Current Transformers. Burden = 3.16 volt-amperes. Power factor = 82.4 per cent.

zero and the errors would no longer exist. In well designed transformers the resistance of the windings is negligibly low, but unfortunately the coupling between windings is not perfect. As insulation requirements demand greater separation the leakage reactances increase and the values of E, Φ and I all become larger. The limiting case is again found in the bushing type transformer where the leakage reactances are at their worst, due to the wide separation between primary and secondary windings.

A third possible solution of this problem would be to replace the high silicon steel ordinarily used for the transformer core with some material whose magnetic properties were such as to require a much smaller component of exciting current. Some such materials have been developed in recent years and are known by such trade names as nicaloi, permalloy, hypernik, "A" metal and others.

Fig. 6 shows the core losses of ring punchings of hypernik compared with silicon steel over the range of flux densities ordinarily met with in current transformers.

Fig. 7 shows phase angles of two 500-5 ampere ring type current transformers, one built with hypernik and the other with high silicon.

Fig. 8 is ratio curves for similar transformers.

We note a very appreciable improvement brought about by the use of this nickel alloy. It might be added at this point that the cost of these

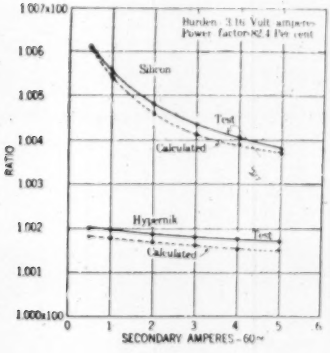

Fig. 8

500-5 Ring-Type Current Transformers. Burden = 3.16 volt-amperes. Power factor = 82.4 per cent.

special alloys would be many times the cost of silicon steel. However, in the case of the two design principles already discussed, the efficiency of the use of the special alloy decreases rapidly as the insulation requirements are increased and as the number of ampere turns is decreased. As a result of this inherent tendency, a high tension transformer of say 200 amperes primary and used in connection with a 100,000 volt bushing would have unsatisfactory characteristics, even though the core were made from the best available alloys.

We have now outlined the ordinary design methods employed in the usual type of transformer all of which have to do with minimizing the exciting current I, and all of which fall far short of the ideal in the case of high voltage transformers, particularly of the bushing type. I would now like to direct your attention to the fourth method which attempts not to remove this disturbing current I from the picture, but rather attempts to introduce a new element which is corrective in its nature and very closely approximates the ideal transformer. I refer now to the two-stage transformer invented by H. B. Brooks of the Bureau of Standards and subsequently developed into a practical, commercial form and first

offered for sale by the Sangamo Electric Company in 1921. Referring again to Fig. 1 we see a typical one-stage current transformer having one primary winding, one secondary winding, and one core.

Fig. 9 shows the elementary diagram of a two-stage current transformer which is in effect two transformers in one. The first built upon the principal core if taken by itself would yield a secondary current approximately correct in ratio and phase but being subject to the disturbing factors of magnetization and so forth, which are common to all one-

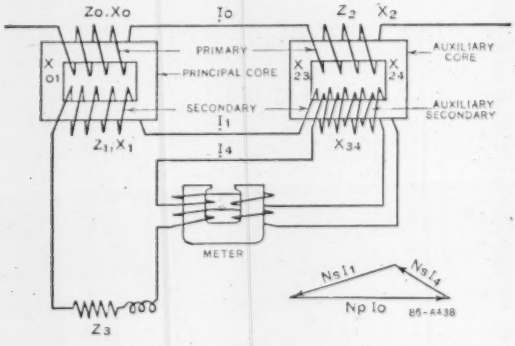

Fig. 9

Effective Ratio and Phase-angle Curves of Precision Circuit (auxiliary secondary) of Sangamo Two-stage Current Transformer.

stage transformers. Both primary and secondary current pass also through the windings of the second or auxiliary transformer, the ratio of turns of which is exactly equal to the nominal ratio of the transformer. These two windings, however, are wound in such a direction that the magnetizing effects of the two currents are opposed to each other and the resulting flux in the auxiliary core is due only to the difference between the currents in the primary and secondary winding. The auxiliary core also has another winding called the auxiliary secondary, having approximately the same number of turns as the principal secondary. This winding is connected to an additional current coil in the meter. Now if operating conditions are such that the secondary current happen to be exactly correct in magnitude and phase, the ampere turns of the two windings on the auxiliary core will be equal and opposite to each other, and no magnetic flux will be produced in this core and likewise there will be no current in the auxiliary winding. If, however, as is usually the case, the principal secondary current differs either in magnitude or phase from the primary, then a flux corresponding to this difference in currents will be set up in the auxiliary core and as a result a current will flow in the auxiliary secondary which will closely approximate the vector difference between primary and secondary current. This current being effectively added in the meter to the principal secondary current gives to the meter almost exactly the registration that it would have were it possible to pass the primary current through the meter.

Referring to the vector diagram in Fig. 9 we see here the primary

ampere turns represented by N_pI_o, the principal secondary ampere turns represented by N_sI_1 and their vector difference which for all conditions of load or secondary burden is automatically added to N_sI_1 is shown by N_sI_4. In practice the two cores would be combined in one structure and the primary and secondary windings link with both cores as shown in Fig. 10.

As a result of several years of observation and study of this particular type of transformer and keeping in mind the fact that the performance of several types of one-stage transformers now on the market is equal to the performance of the other metering devices used in connection with the transformer, we feel that for low voltage measurements

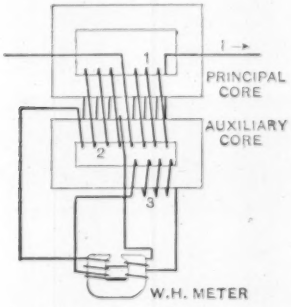

Fig. 10

Circuits of Commercial Two-stage Current Transformer made as a Structural Unit.

the Brooks two-stage transformer is not a necessary refinement except for the most precise measurements such as might be encountered in the laboratory or where very large blocks of power are being metered. However, for high voltage circuits where single-turn current transformers of low ampere turns are demanded, then the Brooks two-stage current transformer fills a place not filled by any other transformer.

Before leaving the subject of current transformer design we should consider also other properties of the instrument, the importance of which may be fully as great as the accuracy curves of the transformer. I have enumerated these properties in approximately the order of their importance altho the relative importance may vary as the transformer is used in different installations. In general these considerations will apply to potential transformers as well.

(1) Performance
(2) Insulation
(3) Thermal properties
(4) Resistance to mechanical strain
(5) Dimensions
(6) Mounting facilities
(7) Arrangement of terminals
(8) Appearance

We have already discussed the first item. The insulation of instrument transformers is a matter of major importance since in a large percentage

of installations insulation itself is the reason for the use of a transformer. Instrument transformers should be insulated to withstand approximately two and one-half times the operating voltage of the circuit. The insulation must be chosen with a view of permanency of dielectric strength as well as ability to withstand high initial test voltages. Since even the life of those who come into contact with metering circuits may depend upon the insulation of the instrument, no compromises at this point can be permitted—nothing but the best is good enough.

The third and fourth items of the above can be considered together since temperature rise and mechanical stresses are both functions of the current flowing and are the same function, viz., the square. A transformer under an overload of twenty times full load will develop heat four hundred times as fast as at normal load. The mechanical strains produced will be four hundred times normal. The importance of designing our instruments to withstand heavy overloads has been emphasized from many quarters, an excellent discussion of the subject being published in the 1921 Transactions of the A. I. E. E. by Phillip Torchio of the New York Edison Company. Tests made and discussed by Mr. Torchio show conclusively the desirability of one turn primary or bus-bar type of current transformers. When because of low primary currents involved one primary turn is not sufficient, then the turns of a primary winding must be made of as heavy section copper as practicable and firmly wedged into position to prevent relative motion of the windings during moments of heavy overload. It should be pointed out at this time that ideal performance, ideal insulation and ideal strength are all conflicting properties and in general the designing of the transformer to favor one of these three is at the expense of the other. It is here that the designer realizes that we can't have everything. It has been our purpose in our standard transformers to give accuracy consistent with the rest of the metering installation, to give adequate insulation and reasonable strength. If special occasion should arise where additional strength or insulation must be had, then we have been compelled to sacrifice some in performance to give these other things. Even insulation and thermal capacity are diametrically opposed since the insulating material usually retards the flow of heat in about the same measure that it is effective dielectrically.

The remaining four of the properties enumerated above can be considered as a group and very often are the criterion by which you meter men judge the instrument. But even here again is a conflict between convenience and performance. You can't put a 200 volt-ampere transformer into the space formerly occupied by a 25-volt-ampere transformer nor does the most convenient arrangement of terminals always make for the best insulation.

Leaving now the special discussion of current or series transformer, we will consider for the moment the voltage or potential transformer. Here the problem of design is a little easier as the variables do not cover

such a wide range of values. Burdens imposed upon potential transformers are apt to be higher than those encountered in the series transformer but fortunately changes in burden are not accompanied by the wide changes in flux in the transformer core that we have observed in the series transformer.

The vector diagram of a potential transformer, which to simplify the discussion may be assumed to have a 1:1 ratio, is shown in Fig. 11.

This diagram like others used earlier is not to scale. Here the voltage applied to the primary is E_p which produces the primary current I_p,

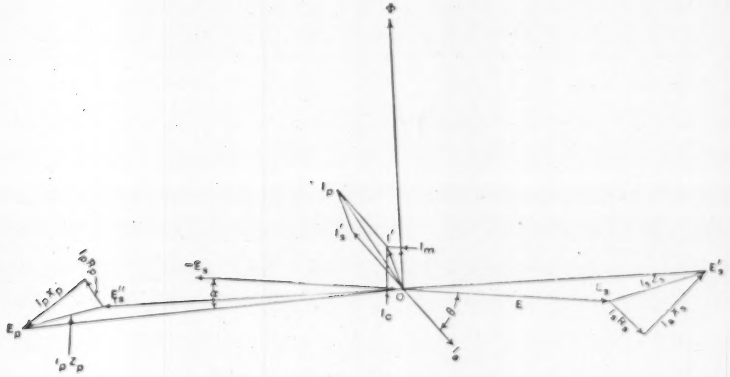

Fig. 11
Vector Diagram of a Typical Potential Transformer.

the same, as in the current transformer, being made up of the reversed secondary current I'_s and the exciting current I'. This likewise is made up of two components I_c supplying the core losses and I_m supplying the flux I. Subtracting vectorially the primary resistance and reactance pressure drops I_pR_p and I_pX_p respectively we have E'_s the primary e.m.f. equal and opposite the secondary e.m.f. E'_s. Similarly subtracting the secondary pressure drops I_sR_s and I_sX_s from E'_s we obtain E_s the secondary voltage. The ratio of the transformer is the ratio of E_p to E_s and α the angle by which $-E_s$ the reversed secondary voltage leads the applied primary voltage E_p is the phase angle of the transformer. In the particular case illustrated in Fig. 11 this angle is negative. We note here that the vector addition of I'_s the reversed secondary current and I' the exciting current give a value of I_p which varies in both magnitude and phase as the value of the angle Θ changes, Θ being the angle between the secondary voltage and current or in other words the power factor angle of the secondary burden. We note also that the absolute phase position of the four vectors I_pR_p, I_pX_p, I_sR_s and I_sX_s all depend upon the value of Θ.

To make a perfect voltage transformer we need only to eliminate three disturbing factors from this picture. These are the vectors I', I_pZ_p,

and I_sZ_s in Fig. 12 which are the exciting current, the primary impedance and the secondary impedance respectively. This you may note is a little more complicated than in the current transformer since in that case the elimination of the exciting current alone is nearly sufficient to give perfect performance. Practically in the potential transformer design we secure our best results by reducing all of the three above mentioned disturbing factors to a minimum which in general is accomplished through observance of the following points:

(1) Selection for core material of iron having low hysteresis and high permeability.
(2) Employment of sufficient iron to make possible low flux densities without using an excessive number of turns per volt.
(3) Use of a closed magnetic circuit carefully built up of well insulated laminæ.
(4) Reduction of magnetic leakage to the lowest possible value.
(5) Liberal design of windings.
(6) Insulation consistent with voltage rating.

It is to be noted here as in the case of the current transformer that these desirable points of construction are not all independent of each other and in some cases the application of one design principle must be at the expense of another. An example of this confliction of design requirements is the conflict between item No. 4 and 6 above. Here we observe that the spacing necessary for insulation always tends to increase the leakage reactance.

Much more might be said on this general subject of instrument transformer design. Certainly the conditions of use of the finished product should have much to do with the design. Convenience of testing, inspection and repair are also necessary considerations. Cost of manufacture must also be given proper attention and standardization cannot be neglected. These factors all contribute their share to the design. So now in conclusion as was said at the beginning of this paper, it is hoped that a mutual study of all of these various factors will result in better instruments and in more advantageous application of the instruments which are already available.

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Die-cast aluminum cases now standard for many instruments of the Brown Instrument Co., lightness, resistance to rusting and corrosion and absence of flaws improve product—increased first cost offset by uniform quality and elimination of grinding and machining operations.

——— : : ———

The Leeds & Northrup Plant will close this year for a period of two weeks in August (from Saturday, the 11th, to Saturday, the 25th, inclusive)—except for a skeleton organization to care for emergency requirements.

A New Turbidimeter

Dr. W. Ewald, Berlin, Germany

DUE to the extensive use of dispersion glasses as light scattering screens in actual practice, especially in the illuminating industry and due to the manifold investigations of turbid mediums in chemical laboratories, the determination of a standard value as an evaluation number for the degree of light dispersion is absolutely necessary.

For the construction of a testing instrument for dispersion glasses and colloid solutions naturally certain conditions must be satisfied. It is required that the instrument permit separately the investigation of the transmission and further the degree of dispersion.

Purely mathematically the problem of light dispersion is far more difficult to solve, as the basic laws with dispersion are at best only known qualitatively. Even with the simple Lambert Law with which the intensity I observed with a reflecting angle α is given $I = I_o \cos \alpha$, only holds for a few materials and with these also only in a limited angle range. The same holds for the expanded formulæ of Lommel, Berry, Sumpner Bloch and Pokrowski.

To have in practice a measure for the dispersion, one first made a series of standard glasses, which possessed a definite standard dispersion. As the laws for the degree of dispersion with opaque glasses are decidedly different than for frosted glasses, such standard glasses were required for the two types. One first fixed six grades for each. The classification was based on photometric measurements, which gave the following values:

I. OPAQUE GLASSES

Class	*Direct Transmission*	*Non-uniformity of the light division*
1	80%	10 000
2	80-50%	10 000-1000
3	50-20%	1 000- 100
4	20- 5%	100- 10
5	5 and 0%	10 and 0
6	0 (totally dispersed)	0

II. FROSTED GLASSES

Class	*Relative light density in the direction of the incident light*
1	direct transmission still present
2	20- but without direct transmission
3	20-15
4	15-10
5	10- 5
6	5

In order to satisfy the requirements in practice several intermediate steps had to be made between the steps 5 and 6. With the instrument described below an extensive classification of turbid materials can be carried out.

It is probably interesting that the classification can also be carried out solely visually, in that a parallel bundle of light rays is made visible in a suitable manner and then the above mentioned turbid standards are placed in the path of the rays of the same. The test is carried out, in that one permits a parallel bundle of rays to fall on a standard plate first measuring the transmitted light and second observes the dispersion cone in a container filled with a suitable colloid solution, which is placed behind the test glass. There results now for the two classes the following relation:

I. OPAQUE GLASSES

Class	*Dispersion image in the colloid solution*
1	Direct light strong, dispersion cone not visible
2	The cone is slightly visible, but still not visible on observation with a red glass.
3	The cone is also plain with a red glass, the directly transmitted light still very strong.
4	The directly transmitted light is medium strong.
5	The directly transmitted light is weak.
6	No directly transmitted light is visible (complete dispersion)

II. SURFACE FROSTED GLASSES

Class	*Dispersion image in the colloid solution*
1	The incident parallel light ray bundle is only spread a little, no cone visible.
2	Parallel light ray bundle is strongly spread, cone only visible without red glass.
3	The cone is also slightly visible with the red glass.
4	The cone is sharp and the original light bundle is so strongly dispersed on the edge of the container, that the outline is hardly visible.
5	The same as 4, only more pronounced.
6	Uniform light cone.

It is evident, that with the aid of this arrangement one is in position to make an extensive investigation of the character of turbid mediums and that this manner of testing has been used for a long time and is at present still partly used. To be sure for the trained individual the visual grouping of a medium of unknown dispersion properties is sufficient, but in all cases the use of at least a set of standard opaque and frosted glasses is advisable.

The recent investigation though has made it possible to produce opaque and frosted glass wedges. The former are either ground direct

from opal glasses or replaced by wedge shaped glass containers, which are filled with a turbid solution. Frosted glass wedges are made by a suitable etching. With the aid of these wedges not only is it possible to judge the opaque glass within a few classes but one is now in position to achieve absolutely satisfactory measurements with the aid of photometric methods.

The different crystal sizes of the suspended particles of the comparison medium and the medium to be tested still presents a difficulty; but this will be overcome in a simple manner by a suitable diaphragming of a spectral range.

Finally a turbidimeter must also permit the measurement of the dispersed light in addition to measuring the transmitted light and the direct dispersed light under about 40°. This value will also be used, especially with mediums, whose direct transmission is equal to zero.

The modern turbidimeter should therefore determine three factors: direct light, direct dispersed light and dispersed light of diffuse reflexion, in order to accomplish in every case the classification of an unknown turbid medium.

It is again specifically pointed out that the measurement of only one of these effects is not sufficient, as there are mediums of uniform transmission, but of different dispersion properties.

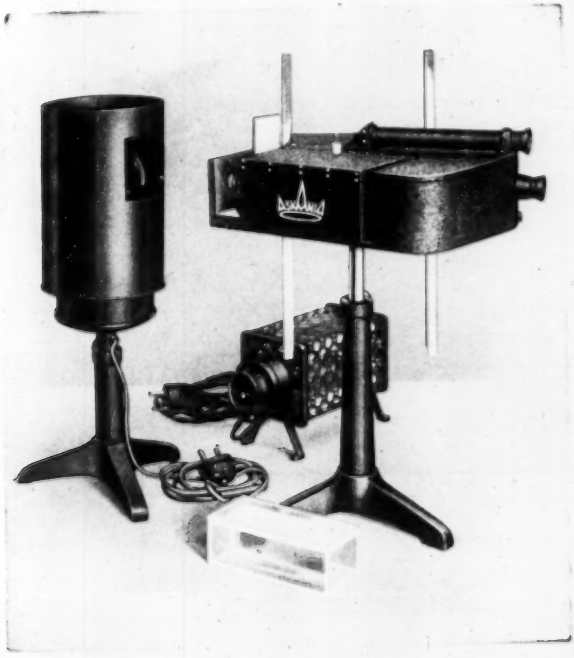


Fig. 1

Below such a turbidimeter is briefly described: Fig. 2 shows the path of the optical rays in the turbidimeter shown in Fig. 1. Two equal light bundles L_1 and L_2, which go out from a light source L (Pointolite lamp), strike two similar objectives O_1 and O_2 and pass through diaphragms

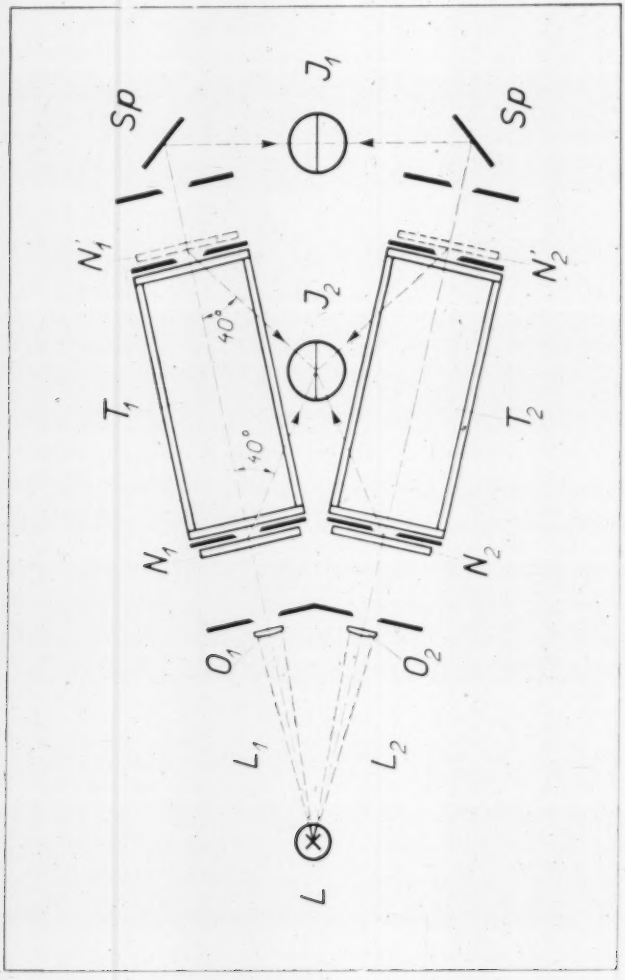


Fig. 2

sharply limited parallel. The light bundles are again brought together in the photometer head J, by the two mirrors Sp and can there be used for measurement. In the path of the rays L, L_1, O_1, J_1, N_1 is a standard turbid wedge, in L, L_2, O_2, J_2; N_2 is the turbid medium to be examined.

The standard wedge N_1 as also N'_1 is adjustable by means of a graduated screw beside the eyepiece and each setting can be read on a millimeter scale. In the photometer head J_1 the direct transmission of the light can be determined by adjusting the two halves of the field of view so that they are equal.

To measure the intensity of the dispersion cone below about 40 deg. the photometer head J_2 is used, as Fig. 2 clearly shows. The photometer head J_2 shows on sighting into it, four divisions in the field of view, of which 1 is adjusted to the corresponding dispersion radiations. In order to carry out the measurement of the dispersed light of the diffused reflection, the standard wedge N_1 is placed in the position N'_1 and the medium to be examined at N_2.

It should still be mentioned, that the instrument after removing the opaque glass wedge can also be used in conjunction with the standard glass sets. Finally also a visual estimation is possible. For this purpose two troughs, which are filled with the colloid solution, serve to make the dispersion cones clearly visible. The particular solution can be preserved and can be used very well in the plant. Due to the possibility of carrying out the measurement of three independent effects, the apparatus described is a measuring instrument of the greatest dependability. The use of a turbidimeter will be of considerable value to everyone who undertakes the making of dispersion glasses and to every chemical laboratory in which investigations of turbid mediums are made.

OIL GAUGE SERVICE

Transparent Bakelite material has been adopted for high pressure oil gauges used on pumping machinery. The construction of oil gauges normally involves the incorporation of a transparent window section within the metal housing of the gauge itself. To secure a liquid-tight gauge unit, resilient gasket material is usually placed between the metal and glass, and the assembly is clamped together through the use of retaining bolts. Frequently, the gauge glass must be of considerable thickness, in order to withstand the operating pressure of the fluid contained. When the glass has been mounted in the oil gauge, it may fracture suddenly when the combined effect of stresses, inherent and applied, has reached a critical point. Subjected to test comparison with various grades of glass made in the United States and in Germany, the Bakelite material is reported to have rated 25% higher than glass, under application of stresses, up to the point of fracture.—Bakelite Information.

Information Section

Correspondence from instrument users and others pertaining to or relative to instruments

THIS section invites correspondence from instrument users and others relative to questions pertaining to instruments.

Names and addresses of manufacturers of instruments will be furnished on special request. Inquiries pertaining to sources of supply should be addressed in writing to our Information Section. Such inquiries will be answered promptly by mail.

Inquiries regarding instrument problems will be answered by publication in this special "Information Section" of INSTRUMENTS. We feel that other besides the inquirers may be interested in the same or similar problems, and in this way all of our readers will obtain the benefit of the information furnished.

No. 2. Can you put us into communication with the manufacturers of the Howard-Dolman Depth Measurement Instrument?—E. F. H.

No. 23. Is there a manometer or other instrument which will indicate the flow of water in a tube one-eighth inch in inside diameter when such flow is from 15 to 600 cubic centimeter per minute?—R.S.G.

No. 27. Would you be so kind as to give us the names of companies manufacturing any instrument that would be of help in measuring and locating vibrating as well as torsional conditions in Diesel engines?—B.C.S.

No. 28. Kindly furnish us with the sources of supply of paper charts on which record may be made by a hard stylus in constant (8 days) contact with the chart, which will fit on a cylindrical drum, and not stretch or shrink with changes of atmospheric conditions?—W.S.H.

No. 29. Furnish us with the names of companies manufacturing a sturdy 8-day clock motor not exceeding 2⅜" diameter by 1 7/16" thickness that will perform satisfactorily with the staffs in a vertical position.—W.S.H.

No. 30. Will you kindly advise us of a manufacturer who makes an instrument for the continuous indication or recording of very low moisture contents in gas currents, specifically from 0.01 to 0.5 or 1% of water vapor in carbon dioxide?—J.F.L.

No. 31. We would be obliged if you would put us in touch with manufacturers (if there are such) of integrating meters reading in gallons the total quantity of milk passing through a 2" pipe at the rate of 1,500 to 2,000 gallons per hour. The manufacturers should give us information as complete as possible particularly as to how sterilization is effected.—R.H. & Co.

No. 32. Thermostatic Control of Industrial gas ovens.—W.R.G.

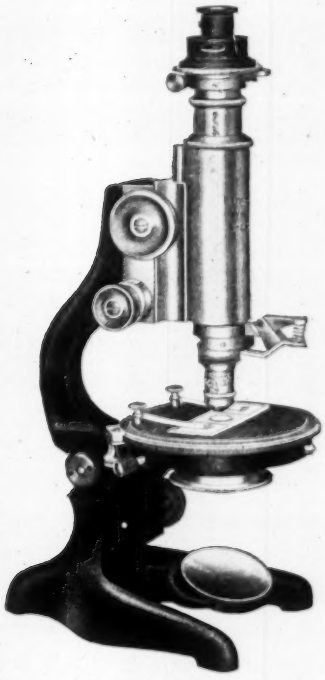
New Instruments

Recently Developed by Instrument Manufacturers

Universal Chemical Microscope

(E. Leitz, Inc.)

THE new Leitz Universal Chemical Microscope is primarily designed for chemical investigations. However, in construction it has been so arranged that through the addition of essential accessories the Microscope adapts itself for the various fields of endeavor in bacteriological, biological and metallurgical investigations. It therefore becomes evident that this Microscope is truly a universal instrument.



It may interest readers to know that for the past five years there had been practically no change in construction of Chemical Microscopes. With the introduction of the new Leitz Microscope "Chem" it is now possible for a Laboratory through means of one Microscope to investigate various materials regardless of whether investigation is to take place by means of

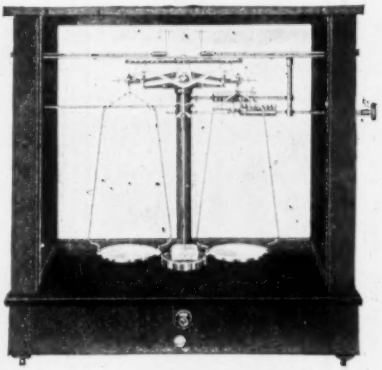
ordinary transparent illumination,
polarized illumination,
reflected illumination,
polarized reflected illumination.

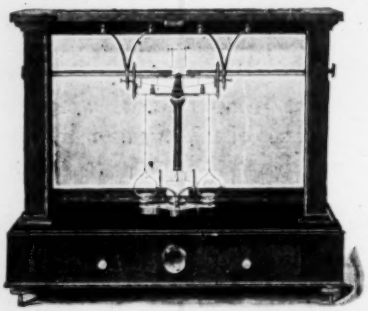
There is no material which will not permit of investigation by either one or the other methods described and the Microscope is so arranged that through a minimum of effort one can readily convert the instrument for the necessary procedure.

The Chemical Microscope permits also of projection and photomicrography so that a record can be kept of any such specimen as merits special interest.

Multiweight Balance

WM. AINSWORTH & SONS, INC., Denver, Colorado, have placed on the market a "multiweight" balance with variable sensitivity attachment, and having a selective device for handling all fractional weights, as used on their more expensive balances. Each weight or rider is on an arm bearing a number corresponding to the weight carried, which may be transferred to a bar attached to the right hand stirrup by the sliding selector on a rod extending through the right-hand end of the case, and which may be moved longitudinally until the indicator stands opposite the number on the rod corresponding to the weight to be transferred, when a slight rotating motion of the operating rod shifts the weight. Any number of weights may be transferred up to the capacity of the carrier (1115 mg.), and when the weighing is finished a slight turn in the opposite direction returns the weights to their respective arms. The variable sensitivity attachment consists of a heavy (gravity) weight or rider that is dropped on a stud attached to the indicator when beginning a weighing, thereby decreasing the sensitivity ten or twenty times according to the weight used, and increasing the speed of oscillation six or twelve times, respectively. When an approximate balance is reached, the gravity weight is lifted and the weighing completed at the normal speed and sensitivity of the balance. The balance has a capacity of 200 grams and is sensitive to 0.05 mg. at half load or 0.1 mg. at full load and is described in their bulletin A-15.





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The Standco Phase Sequence Indicator

(Herman H. Sticht & Company)

THIS instrument serves to show the order of sequence of the E. M.F. in a three phase circuit. The value of such an instrument will be self-evident to anyone who has had occasion to connect up A.C. motors and similar equipment.

After the three wires of a polyphase circuit have been pulled through conduit it is not very easy to "phase them out" and to make the proper connections unless advice of this nature is available.

With the three phases connected to terminals A, B and C in proper relationship, the disc will rotate in the direction of the arrow. A reversal of any phase will cause the disc to rotate in the opposite direction.

The instrument is small (4½ x 3½ and 1¾ inches) and weighs approximately 17 ounces so that it may be carried in the pocket. It has been designed to operate at all voltages from 40 to 600 volts and all frequencies from 15 to 60 cycles per second.

The instrument consists essentially of an aluminum disc rotor and a three phase stator winding. The disc, which is mounted close to the opening in the case for easy observation, has a small black target for observing the direction of rotation.

New Measuring Tools

(Brown & Sharpe Mfg. Co.)

TUBULAR INSIDE MICROMETERS—The new Brown & Sharpe tubular inside micrometers No. 276, shown in Fig. 1 are made for long inside measurements. Due to their tubular construction, they are light and easy to handle. They can be quickly and easily adjusted, and locked at any reading. The measuring points are hardened and the faces ground on a radius, thus adapting them especially for measuring parallel or curved surfaces.

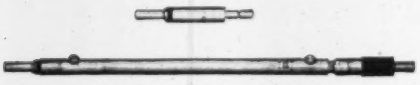


Fig. 1

The range of measurements of each tool is obtained by 10 changeable anvils of different lengths. The shoulders of the anvils fit against the shoulder of the micrometer head insuring positive adjustment and accurate measurements. The anvils can be changed easily and held positively in place by a clamp screw fitting into a V groove.

The size illustrated above, measures from 12″ to 22″. The sizes for measuring 22″ to 32″ and from 32″ to 42″ are similar in construction.

OUTSIDE MICROMETERS.—The new outside micrometers, illustrated in Figs. 2 and 3, are graduated in thousandths of an inch or hundreths of a millimeter. They have solid anvils and a simple adjustment for wear of the measuring surfaces. They have no clamp rings. No. 60 is supplied for the range 1″ to 2″ or 25 mm. to 50 mm.; No. 62 2″ to 3″ or 50 mm. to 75mm.

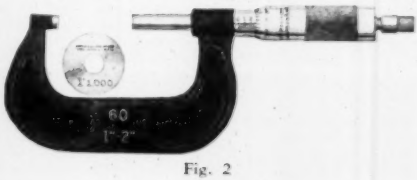


Fig. 2

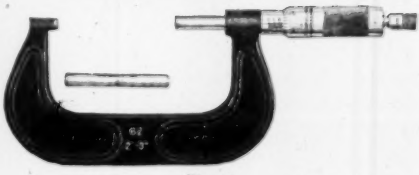


Fig. 3

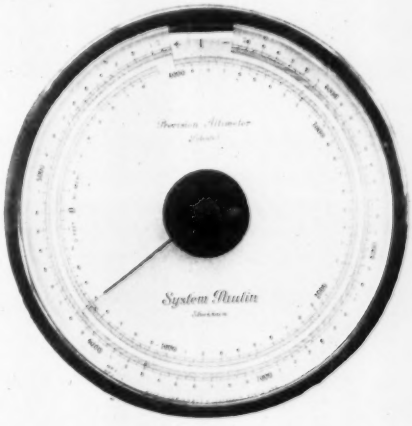
MANNING, MAXWELL & MOORE BUYS AMERICAN SCHAEFFER & BUDENBERG CORPORATION

Charles A. Moore, Jr., president of Manning, Maxwell & Moore, Inc., international engineering specialists, announces the purchase of the American Schaeffer and Budenberg Corporation of Brooklyn, N. Y., and Worcester, Mass., from Ralph Jonas and his associates. The newly acquired company, founded in 1851, is the oldest and one of the largest manufacturers of industrial instruments in the United States

A New Pressure Gauging Instrument

(American Paulin System, Inc.)

DURING recent years a new principle applied to pressure gauging instruments has been developed known as the Paulin System. The claims advanced for Paulin System instruments are that they give an instant response and accuracy in recording a pressure change heretofore unknown. This assures very dependable results and effects in addition great economy in time.



The Paulin System is applicable to many types of pressure gauging instruments. The types which to date have been developed are instruments for measuring air pressures, such as barometers and altimeters. The types which have been developed and which will shortly be on the market are manometers, tank gauges, pressure gauges, blood pressure instruments, aircraft instruments, etc.

The outstanding features of the barometer are those of instantly recording, accurately measuring and graphically showing all changes in air pressure, and that it can be read and understood by any one. This instrument shows the barometric tendency in a distinct and clearly visible manner instantly without tapping and indicates the absolute air pressure at any time.

The altimeter and the barometer function in the same manner, which is briefly described as follows: The tendency pointer (small pointer on dial between minus and plus marks) moves instantly towards plus with even the slightest increase of air pressure or towards minus if pressure is reduced. By turning the button shown in the center of the dial glass, the tendency pointer can be moved right or left up to certain stops on either side. By this means the pointer is accurately centered over the zero line and when this is accomplished the large dial hand, which is fixed to the button, will indicate the correct air pressure at that moment. A change of air pressure will automatically move the tendency pointer toward plus or minus, thus clearly showing if the air pressure is rising or falling and at what rate the rise and fall takes place. If it is desired to measure the amount of such a rise or fall, a reading is taken of the position of the main hand before moving the button to adjust the tendency pointer to its zero position. The position of the main hand before and after taking a reading

denotes the change in pressure in either inches of mercury or feet of altitude.

The Altimeter will measure differences in elevation with more speed and greater accuracy than any other instrument except the precise level and transit. It is therefore a most useful instrument for engineers, explorers, geologists, etc., and also for aviators, especially in connection with aerial photography and surveying.

The reasons why these instruments function with such precision can be summarized briefly as follows:

1. The zero or null gauging method is used, which is the most accurate method known for measuring or weighing anything. It means in this case that the air column is weighed against the tension of a spring, the tendency pointer being at zero when exact balance is reached. The instrument is acting the same as a pair of balances and it measures a change in the weight of the air column equally accurate at sea level or at the extreme range of the instrument, which may be 10,000 feet above sea level. The measuring mechanism, which in the case of these instruments is a metal diaphragm, is brought to the same normal position by the change of tension in the spring, by turning the button, no matter at what elevation the measurement takes place. This method of measuring practically eliminates elastic hysteresis.

2. The instrument does not contain any chains, gears, bearings, pivots or other friction producing mechanism. In other words, there is no inertia due to friction to overcome when the mechanism within the instrument starts to move, and there is no loss or lag due to friction while the mechanism is moving as no moving part moves against any other part. As all moving parts are solidly connected there is no error from lost motion.

3. The instrument is compensated for change in temperature by a very simple and effective means only applicable to Paulin System.

NOVEL METER TEST

Tests recently were made in a novel manner on two large meters without disconnecting or removing them from service. The meters are set in series in the basement of the Distribution Service Station at 1800 N. 9th Street and measure the gas used in the meter repair shop on the sixth floor of the building. When the shop was shut doyn and all gas outlets turned off, gas was allowed to pass through the meters, through the tight piping system, and was used to raise the bell of a prover seven stories from the meters. A proof of each of the meters was obtained by comparing the registration of the meters with the readings of the prover. As one of the meters weighs about seven hundred pounds and the other is no feather some trouble was saved by obtaining the proofs in that way.—U. G. I. Circle.

Durac—An Improved Hydrometer

(Hiergesell Brothers)

IN many laboratory and industrial processes the specific gravity, or density, of liquids must be determined with reasonable accuracy—yet, withal, quickly. Hence, the widespread popularity of Hydrometers. Float them in the liquid under observation and read the scale; that's all there is to it, unless the degree of accuracy required makes temperature corrections necessary.

While the technique for hydrometers is very simple, heretofore their use has been hampered by a number of petty annoyances. Undulating surfaces ending with a slender-necked spherical ballast bulb made them hard to clean and extremely susceptible to breakage. In order to avoid these drawbacks and to improve the "usability" of the instrument a detailed revision of the mechanical design was undertaken. The result of this investigation is shown in the illustration. From its greatly increased durability and accuracy this new model derives the name Durac.

Especially interesting is the novel method of attaching the ballast element. A conical chamber containing mercury is welded to the bottle-like bottom of the float. Thus the section of greatest weakness in older models becomes the section of greatest strength in the Durac. Breakage at this point, even under roughest handling, is said to be extremely rare.

Aside from greater durability this "cone on a bottle" feature provides a smooth exterior. Where the wasp waist of yesterday was hard to clean and most likely to snap off (thus ruining the instrument) this new shape is dried with a single wipe—a convenience much appreciated by those doing routine hydrometry.

The tapered ballast chamber does its share towards accuracy of reading, too. Not only is it easier for the instrument maker to load in the exact weight of mercury for any given minimum immersion, but also the conical form assures precise centering of the ballast on the vertical centerline of the instrument. Thus perfect flotation is attained—with scale markings always parallel to the surface of the liquid. This is of special importance where divisions of the scale are close together.

As one views the middle and upper parts of the Durac, the appearance is somewhat that of the conventional styles. At its

top the Durac float chamber narrows down to the diameter of the stem with possibly a longer taper than is usually found. The reason given for this is that surface friction is increased to some extent. Acting in conjunction with the taper in reverse direction at the bottom (the ballast chamber) the instrument does come to rest almost at once —even when carelessly dropped into the liquid under test.

A HYDROMETER FOR EVERY PURPOSE

Durac models are to be had for everything from alcohol production to zinc processes; from gasoline to glue—in all standard scales—Specific Gravity, Baumé, A.P.I., Brix, etc.; also in a number of special scales peculiar to certain industries. Overall lengths and ranges comply with general custom and are based on the experience gained in making more than a million of the old style instruments.

All scales are hand-calibrated, three reference points being secured for each instrument by immersion in liquids with surface tensions appropriate for the use to which the instrument will be finally put. After calibration, the scales are securely fastened in place with an ever-holding cement. They are then re-checked and made ready for shipment in specially designed safe-carriage cartons.

Although radically different in design, Durac Hydrometers are guaranteed to meet the specifications of the Bureau of Standards and those of the various engineering societies. Serial numbers provide a means of ordering duplicates. In every way the Durac is truly a standardized product.

HYDROMETER ACCESSORIES

Many of the larger companies using hydrometers have fixed routines for testing. One of the usual requirements is a tall cylindrical container for the liquid being inspected. Accordingly, the makers of Durac Hydrometers are now supplying a copper cup 14" high and of such diameter as to give the instrument plenty of room. A widely flaring base gives stability and a handle affords ease in dipping up samples.

A plain model with beaded rim is made for use with opaque liquids—but it may also be used for transparent liquids as well, readings being made by the "flush full" method of sighting directly across the brimming surface. For use where temperature corrections are made of a model with vertical sight-glass chamber may be had—with a certified thermometer on a scale plate that fits into the sight chamber.

Other accessories include thermometers calibrated in either F. or C. for total or partial immersion.

Catalogue Library

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Automatic Temperature Control

Trent automatic control gauges for temperatures up to 1000°F is the subject of Leaflet TA-18 published by Harold E. Trent Company, 439 N. 12 St., Philadelphia, Pa.

Better Pickling Equipment

Better Pickling Equipment is the title of a bulletin distributed by the Colonial Supply Company, 217 Water Street, Pittsburgh, Pa.

Bristol's for Blast Furnace, Coke Oven, By-Product and Steel Plant

This bulletin tabulates very thoroughly the applications of the wide line of Bristol instruments in the Coal and Iron Mines and Limestone Quarry, By-product coke plant, Blast Furnace, Sintering Plant, Rolling Mills, Structural Steel Plant, Open Hearth, Soaking Pit, Wire Mill, Electrical Department, Laboratory, Malleable Iron and Gray Iron Foundry, Armour Plate Department, Sheet Mill and Tubing Plant. The Bulletin number is 366 and is issued by The Bristol Company, Bristol, Conn.

Celite Cross Sections

Issued by the Celite Products Company, Los Angeles, Calif., contains the following articles in the June issue: In World-Wide Service; Engineer Makes Short Work of Insulating Argentine Refinery Equipment with Sil-O-Cel; and several other articles.

Consistency Tester

Bulletin B-100, issued by The Braun Corporation, 363 New High Street, Los Angeles, Calif., briefly describes the G-H Consistency Tester for determining the consistency of greases, soaps, creams, vegetable compounds or any other semi-solid.

Contact Control

The Type "H" Pressuretrol developed by the Minneapolis Honeywell Regulator Co., Wabash, Ind., is briefly described and illustrated in their leaflet SA-124-7500-3-28 TRB.

Chronographs

Bulletin 115a issued by The Gaertner Scientific Corporation, 1201 Wrightwood Ave., Chicago, Ill., lists their Tape Recording Chronographs.

Earth Inductor

The Gaertner Modified Model E 1280 Earth Inductor is briefly described in Bulletin 114 of The Gaertner Scientific Corporation, 1201 Wrightwood Ave., Chicago, Ill.

Flammable Vapor Indicator

A leaflet issued by the Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa., briefly describes an instrument designed to continuously indicate the degree of inflammability, or proximity to explosive conditions, of combustible gases or vapors liberated in processes such as lacquering, japanning, etc.

Flow Meter

Leaflet No. VI issued by the Matheson Co., North Bergen, N. J., illustrates their regulator which maintains a steady flow of gas at a fixed rate.

Gas Service Journal

The June issue of the Gas Service Journal issued by the Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, Pa., contains the following articles: Pressure Regulation, Coal Boilers are Successfully Converted to Gas, Gas Refrigeration, Boring Machine.

Hydrometer

Special Catalog F issued by Hiergesell Brothers, 2007 Bellevue Ave., Philadelphia, Pa., covers their Durac Hydrometers.

Harmonic Analyzer

Bulletin 117 issued by the Gaertner Scientific Corporation, 1201 Wrightwood Ave., Chicago, Ill., covers the 20 Element Michelson Harmonic Analyzer.

Inco

Vol. VIII, No. 2, of Inco, published by the International Nickel Company, 67 Wall Street, New York, N. Y., contains the following: "And the Greatest of These"; Sausage Linking costs cut 63%; Welding Monel Metal and Nickel; The Vine ripened Cranberry is now on the Market; and a number of shorter articles.

Mechanical Equivalent of Heat Apparatus

Bulletin 116 of the Gaertner Scientific Corporation, 1201 Wrightwood Ave., Chicago, Ill., describes and illustrates a simplification of the apparatus used by Rowland in his classical experiments.

Mercoid Controls

A. D. 130-5M-3-28 published by the Accessories Division of the American Radiator Company, 40 West 40 Street, New York, N. Y., covers very thoroughly a number of typical installations of Mercoid Controls and Arco Motor Valves.

Measuring Machine Running Time

R. W. Bumstead, 51 Howland Terrace, Worcester, Mass., has available a reprint on The Advantages of Measuring Machine Running Time.

Mikrotast Gauges

Mikrotast Gauges, manufactured by Fried-Krupp, Essen, Germany, is described in a catalogue issued by the Coats Machine Tool Co., Inc., 110-112 West 40 Street, New York, N. Y. This covers external cylindrical gauges, internal cylindrical gauges, external and internal taper gauges, thread gauges and special fixtures.

Ohmmeters

Bulletin No. 300, issued by Roller-Smith Company, 233 Broadway, New York, N. Y., covers their portable, direct reading, slide wire ohmmeters, and circuit tester.

Oxwelded Industrial Piping

The Linde Air Products Company, 30 East 42 Street, New York, N. Y., have just issued a booklet with the above title.

Gas Detector
A report on the new gas detector "Cajo" is being distributed by the Colonial Supply Company, 217 Water St., Pittsburgh, Pa. This instrument is designed to locate leakage of gas by a very novel principle. It can be used for gas both lighter and heavier than air.

Instrument Investment News
The July issue of Instrument Investment News published by American Schaeffer & Budenberg Corp., 338 Berry St., Brooklyn, N. Y., contains the following: The Quality of Bricks depends on its Proper Curing; Increases Ice Production two tons per day; Precision Controller for Many Heating Operations; A Recording Thermometer that Checks Itself; Quality and Production of Ice Depends on the Temperature; Testing Milk Bottles.

Hydrogen Ion Concentration
The New Hellige Comparator is described in their literature No. 1034E issued by Hellige-Klett, Inc., 179 East 87 St., New York, N. Y.

Permanent Magnets
A booklet available for distribution by the Thomas & Skinner Steel Products Company, Indianapolis, Ind., is a very complete, brief treatise on permanent magnets.

Power Specialist
The June issue of The Power Specialist issued by the Johns-Manville Corporation, 292 Madison Ave., New York, N. Y., contains a number of interesting articles on packing.

Price List
J. T. Baker Chemical Company, Phillipsburg, New Jersey, have issued a new price list dated July 1, 1928.

Prestometer
The Prestometer, a gauge for Tool Room and Production Inspection, is distributed by the Coates Machine Tool Co., Inc., 110-112 West 40 St., New York, N. Y.

Pyrometers
B-4-P-300-628 issued by the Leeds & Northrup Company, 4901 Stenton Ave., covers their potentiometer recording pyrometer.

Remote Indicator and Recorder
The Tanner Remote Indicator and Recording Meter for the remote indication of liquid level; position of head gates, penstock valves, gas tanks; or for recording any straight line or angular motion or displacement is covered by literature issued by The Tanner Engineering Company, Rawson Street and Nelson Ave., Long Island City, N. Y.

Radiation Pyrometer
The K. & S pocket radiation pyrometer is described and illustrated in Bulletin 100, published by the Colonial Supply Company, 217 Water Street, Pittsburgh, Pa.

Solenoid Valve
The Arco Solenoid Valve is described in recent literature issued by the Accessories Division of the American Radiator Company, 40 West 40 St., New York, N. Y. The valve is of the adjustable type for oil, gas, water and air.

Tachometer
A leaflet of the Gaertner Scientific Corporation, 1201 Wrightwood Ave., Chicago, Ill., covers their speed indicator "Probator" combined with an antimagnetic watch.

Tachometer
The Coats Hand Tachometers are described in a leaflet issued by the Coats Machine Tool Company, 110-112 West 40 Street, New York, N. Y.

Tycos—Rochester
The July issue of Tycos-Rochester, published by the Taylor Instrument Companies, Rochester, New York. The following interesting articles are contained in this issue: The World Wide Study of Glaciers; The Story of a Lonely Weather Station; Sentinels of the Sea; Flood Warnings Save Millions; Modern Hotel Health Comforts; Guarding the Ships From Icebergs; Weather Bureau Installs New System of Telegraph Reports; What People Ask the Weather Man; Blank Maps for Weather; When Every Home Laundry Will Need a Thermometer.

Temperature Regulators
How Sarco Temperature Regulators Work is illustrated in a leaflet issued by the Sarco Company, 183 Madison Ave., New York, N. Y.

Thermometers, Hydrometers, Barometers, Psychrometers, Hygrometers
Are described in General Catalog E, published by Hiergesell Bros., 2007 Bellevue Ave., Philadelphia, Pa.

Valves
Powell Steel Valves are covered in a bulletin distributed by the Colonial Supply Company, 217 Water Street, Pittsburgh, Pa. The bulletin takes up the physical properties of the materials making up the valve and illustrates the various stock types.

Viscosity Tubes
Circular A, issued by R. P. Cargille, 26 Cortlandt Street, New York, N. Y., covers products for testing Paints, Varnishes, Lacquers and Colors.

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- ☐ 6. Duroc—An Improved Hydrometer

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Instruments Book Shelf

Orders for copies of the books reviewed in this section can be sent to Instruments Book Shelf, care of Instruments Publishing Company, 1117 Wolfendale Street, Pittsburgh, Pa.

MEASUREMENT OF AIR FLOW. *E. Ower.* Chapman & Hall, Ltd., 1928. Cloth, 199 pages, $5.00.

REVIEWED BY M. BERG RIMBACH

This book fills a real need as a text book for students and as a work of reference for engineers engaged in fan engineering and the ventilation of mines and buildings. It deals with the theory and technique of the measurement of air flow, primarily from the practical side. No detailed mention is made of methods and instruments suitable only for laboratory use as distinct from industrial, but references to literature dealing with these matters are given.

The instruments taken up in the book include: pressure tube anemometers; orifice plates; venturi tubes; nozzles; cup, swinging plate and vane anemometers; and hot-wire anemometers.

Other subjects covered are: design of pitot and static tubes, flow of air in pipes, measurements of flow and resistance with pitot static tubes, methods of flow measurement depending on pressure observations and manometers.

Prominence is given throughout the book to the practical aspects of the subject, but the theoretical basis of the methods employed is included.

THE MODERN CALORIMETER. *Walter P. White.* Chemical Catalogue Company, New York, N. Y., 1928. Cloth, 194 pages, $4.00.

Review by Arthur Schroder on page 9 of the July issue of INSTRUMENTS.

Current Literature Review

Abstracts on instruments of interest to instrument readers

Inexpensive Spectrometric Apparatus for Industrial Purposes. F. Stanley, Instrument World, May 1928, pp. 11-12.

Instruments of Bellingham & Stanley, Ltd., are described.

A Dictionary of Technological Science and Trade Terms Applied to Scientific Instruments. William Swaine, Instr. World, May 1928, pp. 13-14, 18.

Introduction to a dictionary now in preparation is given.

Some Recent Improvements in the Design and Construction of Surveying Instruments of British Manufacture. Instr. World, May 1928, pp. 15-18.

Instruments of Cooke, Troughton & Simms, Ltd., described.

Optical Instruments for the Examination of Materials. Herman Ehlbert, Instrument World, May 1928, pp. 23-25.

The Busch microscopes are illustrated.

Guarding Valuable Liquids. Ind. Power, June 1928, pp. 56-58.

The measurement of oil and varnish briefly discussed.

Tremendous Saving Effected by Meters. Ind. Power, June 1928, pp. 66, 68.

Use of meters in a railroad power plant briefly mentioned.

Astronomical Position Determinations with the Wild Universaltheodolite (Astronomische Ortsbestimmunger with the Wildschen Universaltheodolit). F. Ackerl Allgemeine Vermessungs-Nachrichten, April 11, 1928, pp. 233-236; April 18, 1928, pp. 249-255.

The methods of using the instrument are given. Time determination. Determination of meridian and ozimuth.

The Development of the Suspension Theodolits (Zur Entwicklungsgeschichte des Haengethodolits). K. Luedemann Allgemeine Vermessungs-Nachrichten, April 25, 1928, pp. 271-276.

Historical. Instrument developed by Hildebrand is described and illustrated.

The Continuous Measurement of High Temperatures in Operation (Die Betrubsmaessige Dauermessung hoher Temperaturen). Karl Holzhausen, Messtechnik, April 22, 1928, pp. 91-93.

Requirements of an arrangement for the continuous measurement of high temperatures. Disadvantage of the thermocouple. Advantages of the optical pyrometer. Use of an accessory when measuring furnaces under draft. Requirements, which must be fulfilled. Description of an arrangement satisfying all requirements.

The Accuracy of Measurement of Distances with the Small Distance Measuring Instrument of M. Hensoldt (Die Genauigkeit der Messung von Entfernungen mit dem Kleimen Entfernungsmesser von M. Hensoldt). Karl Luedemann, Allgemeine Vermessungs-Nachrichten, April 4, 1928, pp. 217-219.

Brief discussion with table showing results obtained.

The Development of Extensometers for Small Measured Lengths (Beitrag zur Entwicklung von Dehnungsmessen kleiner Messlaenge). K. Boettcher, Zs. Instrumentenk, May 1928, pp. 234-247.

Continuation of article in the April issue. Tests with the new extensometer. Measuring accuracy. Size of errors.

Distance Measurement of Electrical Quantities (Fernmessung Elektrischer Groessen). G. Keinath, Messtechnik, April 22, 1928, pp. 85-87 (cont'd).

The article covers the various arrangements for the distant measurement of electric current, tensions and outputs, as they are required daily more and more in the large power systems. The various methods are discussed.

Material Testing Machines (Materialpruefmaschinen). W. Deutsch, Messtechnik, April 22, 1928, pp. 88-90.

Continued from the March issue. Historical. Tensile Machines. Measurement of force. Calibration. Machines for hardness testing, technical tests, dynamic tests, fatigue tests, torsion tests, wear tests.

What Size the Standard Notched Bar Impact Test? (Welche Kleine Kerbschlag-Normalprobe?) P. Fischer, Kruppsche Monatshefte, April 1928, pp. 53-60.

The importance of standardizing on at the most two sizes of test pieces is discussed. The various methods of test are described. Charts show the dimensions of the test pieces.

The Siemens Factories at Siemens-stadt near Berlin where the OHMERS, MEGOHMERS and GROUND-OHMERS are manufactured.

For descriptive literature, write to

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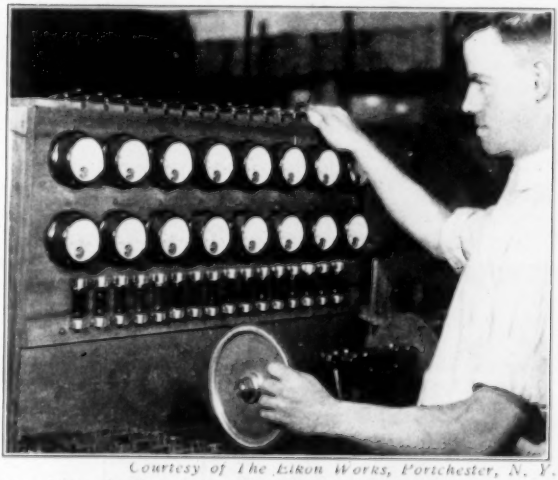
Other Standco Specialties include Tachometers, Tachoscopes, Speed Indicators, Phase Sequence Indicators, etc.

Hoyt

Instruments are used by leading manufacturers on many types of shop test and inspection panels for checking products as they go through production. Hoyt meters are accurate and rugged, yet reasonable in price.



Courtesy of The Elkon Works, Portchester, N. Y.

Test panel in the laboratory of the Elkon Works, Portchester, New York. 16 Hoyt meters used in forming rectifying units.

Hoyt Electrical Instrument Works Boston, Mass.

Various Methods of Connecting Indicating Wattmeters. John Auchencloss, G. E. Rev., July 1928, pp. 376.

Part II continues the connections for three-phase four-wire circuits. This installment also takes up measurements in connection with a high-tension line and reactive volt-ampere meters.

The Photo-electric Cell. L. R. Koller, G. E. Rev., July 1928, pp. 373-375.

The origin of the cell is mentioned and the present day cell is described and its characteristics given.

Gas Analysis Solutions. F. M. Reiter, Gas Age-Record, July 7, 1928, pp. 6-8.

The solutions used in gas analysis are given.—M.B.R.

Measuring Gage-blocks by Light Waves. F. Koenig, Machinery, July 1928, pp. 809-813.

The use of the New Zeiss Interferometer for checking gage blocks is described.

The Dielectric Polarization of Liquids. I. The Dielectric Constants and Densities of Solutions of the Chlorobenzeenes in Benzene and in Hexane. C. P. Smyth, S. O. Morgan and J. C. Boyce, Jl. Amer. Chem. Soc., June 1928, pp. 1536-1547.

A capacity bridge for the measurement of dielectric constants is described.—M.E.H.

The Dielectric Polarization of Liquids. II. The Temperature Dependence of the Polarization in Certain Liquid Mixtures. C. P. Smyth and S. O. Morgan, Jl. Amer. Chem. Soc., June 1928, pp. 1547-1560.

The dielectric constants of solutions of ethyl bromide, chloroform and chlorobenzene in hexane have been measured with a capacity bridge over the entire range of temperature and concentration within which the mixtures are liquid and the densities have been determined with a special form of pycnometer. A measuring condenser and the pycnometer are described and diagrams given.—M.E.H.

A New Equilibrator: A Device for the Determination of the Distribution Ratio of a Volatile Solute between Two Miscible Solvents. Grinnell Jones and B. B. Kaplan, Jl. Amer. Chem. Soc., June 1928, pp. 1600-1603.

A description is given of a new device, called an equilibrator, which by mere rotation acts as an automatic circulating pump, forcing a gas or vapor to bubble continuously and in turn thru two separated liquids.—M.E.H.

Apparatus for Determining Melting Points. S. Avery, Ind. Engg. Chem., June 1928, pp. 570.

A Thiele tube is modified to accommodate a motor-driven stirrer and an Anschütz total-immersion thermometer.—M.E.H.

Accelerated Tests of Organic Protective Coatings. Percy H. Walker and E. F. Hickson, Ind. Engg. Chem., June 1928, pp. 591-596.

Apparatus for exposing organic protective coatings to artificial light, water, and gases is described. The difficulty of determining the relative condition of protective coatings is discussed and the reliability of opinions based on visual inspection is pointed out. Several methods of quantitatively measuring the extent of failure of such coatings are described.—M.E.H.

Adhesion of Films. Further Results on the Adherence of Films to Various Surfaces. H. A. Gardner and A. W. Van Heuckeroth, Ind. Engg. Chem., June 1928, pp. 600-601.

The Gardner-Parks Tensile Strength Meter is adapted for the quantitative determination of the adherence of films. Diagram is given.—M.E.H.

Effect of Physical Characteristics of Coke on Reactivity. I. D. Davis and D. A. Reynolds, Ind. Engg. Chem., June 1928, pp. 617-621.

Results of reactivity tests of low and high-temperature cokes in air, steam and carbon dioxide over temperature ranges from 800 to 1100 degr. C. are given. The effects on reactivity of bulk density, volatile matter, adsorptive power, size of test particles and varying reactivity of particles of the same sample have been estimated. Apparatus is briefly described.—M.E.H.

Automatic Apparatus for the Determination of Small Concentrations of Sulfur Dioxide in Air. Moyer D. Thomas and Robert J. Cross, Ind. Engg. Chem., June 1928, pp. 645-647.

An automatic apparatus has been constructed to analyze continuously air containing sulphur dioxide in concentrations from 0.1 to 60 p. p. m. The apparatus measures out the absorbing liquid, draws a definite volume of air sample through it, and discharges the aspirated solution into a bottle ready for titration. A modification of the automatic apparatus suitable for field work is described.—M.E.H.

Effect of Alkali-Metal Compounds on Combustion. C. A. Thomas and C. A. Hochwalt, Ind. Engg. Chem., June 1928, pp. 575-577.

Apparatus has been developed for measuring the flame-extinguishing property of various compounds, particularly alkali metal salt solutions, towards oil flames.—M.E.H.

New Indicating Equipment for Industrial pH Measurements. Henry C. Parker, Ind. Engg. Chem., July 1928, pp. 676-680.

Three new potentiometers are described. Two of these have scales which indicate pH directly. The technic required for making measurements with industrial types of quinhydrone and hydrogen electrodes is described. The limitations regarding the use of the quinhydrone electrode and the relative suitability of H-ion and conductivity measurements are discussed.—M.E.H.

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Amateur Photomicrography. P. M. Mallet, Photographe, March 1928, pp. 99-103.

A preface and the first chapters of an elementary discussion of photomicrographic work; optics, lenses, choice of microscopes, and construction details are discussed.

—Abs. Bull. Kodak Res. Labs.

Methods of Measuring Ultra-Violet Radiation. W. W. Coblentz, Radiology, Feb. 1928, pp. 116-121.

The author discusses the various methods of measuring ultra-violet radiation and recommends the-vacuum thermopile as most suitable. The precautions to be observed in using the thermopile for measuring ultra-violet radiation and in spectroradiometry are described.

—Abs. Bull. Kodak Res. Labs.

The Filmograph Densitometer. Photographe, Feb. 20, 1928, p. 62.

A method is described of adapting the Filmograph densitometer to the measuring of densities on paper by reflected light. A light beam from an auxiliary lantern strikes the paper at an angle of 45° and the fraction of the light diffused normally to the surface is measured by the photometric head.

—Abs. Bull. Kodak Res. Labs.

Dynamo Tests as Made at the Franklin Institute Fifty Years Ago. Dr. Howard McClenahan, U. G. I. Circle, May 1928, pp. 22-24.

Tests made on five dynamos at the Franklin Institute in 1877 and 1878 are described.—M.B.R.

Meter Reading Practice. T. B. Arnold, U. G. I. Circle, May 1928, pp. 44-45.

The trials and tribulations of the meter reader are given.—M.B.R.

Geophysical Prospecting for Oil Resources. Oil Engg. & Technology, March 1928, pp. 83-84.

Modern developments and their application to the oil industry.—M.B.R.

Geophysical Prospecting for Oil Resources. Oil Engg. & Technology, April 1928, pp. 131-132.

The Oertling torsion balance is described and illustrated.—M.B.R.

Field of Use of Several Technical Measuring Devices. (Anwendungsbereich einiger technischer Messgeraete.) P. Geiger, Zs. V. D. I., 1928, pp. 350-351.

Tests with torsion testing instruments and vibrographs of the Lehman & Michel Company.

The Two Watt Meter Method in Praxis. (Das Zwei watt meter in der Praxis.) F. Kelbe, April 1928, pp. 172.

Rotary Vector diagram, system Westermann by means of which quick computation of total output from indications of two wattmeters can be performed.—G.B.K.

The Gyroscopic Compass. Instrument World, June 1928, pp. 47-49.

The Brown Gyro compass is briefly described.—M.B.R.

The Moving Iron Instrument. John F. Sutton, Instrument World, July 1928, pp. 69-70.

The errors in the moving iron instruments are listed and the properties which a good moving iron instrument should have are given.—M.B.R.

The Errors of a Reflecting Prism. Instrument World, July 1928, pp. 75-76.

Review of a paper read before the Optical Society. The errors are taken up. The ideal diagram is illustrated as well as the actual diagram. The second order errors of a constant deviation prism as discussed.—M.B.R.

A Contour Measuring Projector. Instrument World, July 1928, pp. 77-79.

The contour measuring projector of the Bausch & Lomb Optical Company is described and illustrated.—M.B.R.

The Measurement of the Displacements of Vehicle Springs under Road Running Conditions. Special Report No. 8 Department of Scientific and Industrial Research.

This Report is the second of the series describing the more important investigations of the Springs Research Committee appointed by the Department of Scientific and Industrial Research to consider the best materials and design for laminated and coil springs.

No information was found to be available as to the number and amplitude of the oscillations of the springs of vehicles in practice, and the National Physical Laboratory was asked to devise an apparatus which could be fitted on a vehicle and give a continuous record, under practical road running conditions, of the displacements of the springs relative to the body of the vehicle when run at different speeds and on different road surfaces, and the number of amplitude of the oscillations. A description of the apparatus, and the results obtained from tests made on two Army Lorries and a two-seater motor car, form the subject of the report.—M.B.R.

Are the Newfangled Boiler Room Devices Worth their Cost. Morgan G. Farrell, Ind. Power, Feb. 1928, pp. 50-55, 140.

The apparatus discussed in this article includes: fluid and steam flow meters, pressure gauges, carbon dioxide recorders, draft indicators, thermometers, pyrometers, watt-hour meters, coal and ash scales, soot blowers, feed water heaters, feed water treatment, forced-draft systems, steam traps, steam purifiers, power-factor meters and heat insulators.—M.B.R.

Removing the Guess from Blow Down. J. A. Holmes, Ind. Power, Feb. 1928, pp. 61-65.

Methods of determining the concentration in the boiler are briefly mentioned.—M.B.R.

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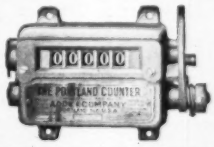

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On the Construction and Standardization of an Interferometer Pressure Gauge. J. J. Manley, Proc. Phys. Soc. Part 2, Feb. 15, 1928, pp. 57-61.

The author describes the construction of an instrument which deals with the application of a Michelson interferometer for the determination of gas pressures ranging from 0.0001 to 20 mm. of mercury.—Abs. Bull. Kodak Research Labs.

New Apparatus for Cine Photomicrography. C. B. Neblette, Photo-Era, April 1928, pp. 235-236.

Three cine photomicrography set-ups are described: (1) The apparatus of Leitz of Wetzlar consists of a microscope, electrically-driven camera, and arc light; (2) the Zeiss equipment consists of spring-driven Ica Kinamo, Zeiss "Microphote" attached to a standard microscope, and a separate illumination system; and (3) the amateur standard set-up of Tuttle of the Eastman Kodak Co. uses a Bausch & Lomb microscope assembly with an electrically-driven Model A Ciné-Kodak.—Abs. Bull. Kodak Research Labs.

Photography in Science. I. Hackh, Camera Craft, April 1928, pp. 170-174.

A few of the applications of photography to biology.—Abs. Bull. Kodak Research Labs.

Photomicrography in the Service of Science and Industry. C. B. Neblette, Photo-Era, April 1928, pp. 203-206.

Photomicrography is treated historically and a discussion follows with regard to its present value to industry. In the case of certain substances such as metals, alloys, sugar, oils, cellulose products, paper, high explosives, colloids, and leather goods, an analysis by photomicrography is often of more value than a chemical analysis.—Abs. Bull. Kodak Research Labs.

Experiments in Ultra Violet Refractometry. L. C. Martin, Trans. Opt. Soc., 1927-28, No. 1, pp. 1-21.

The experiments described have for their object the application of critical angle methods for the refractometry of liquids in the ultra-violet. A thin film of liquid can be held between two quartz hemispheres which are traversed centrally by an approximately parallel beam; the film receives the radiation at the varying angles of incidence resulting on rotation of the system. In this way, analyzing the transmitted radiation with the aid of a quartz spectograph, the critical angles for definite wave-lengths are measured, from which refractive indices can be calculated. The procedure necessary in seeking precise results is discussed, and a series of measurements on glycerine-water mixtures likely to be useful for immersion fluids in ultra-violet microscopy is given. A set of interesting phenomena of the extinction bands is described and explained.—M.B.R.

The Construction of Wave-Length Scales for Spectrograms. Guy Barr, Trans. Opt. Soc., 1927-28, No. 1, pp. 22-27.

A method is described by which an approximate scale of wave-lengths may be projected geometrically from a uniformly divided scale on a spectrogram wherein a sufficient number of lines have been identified to enable constants of a Hartmann interpolation formula to be derived. Such a scale is of value in assisting the recognition of other lines between which accurate interpolation may be required.—M.B.R.

The Design of Reflecting Prisms. T. Y. Baker, Trans. Opt. Soc., 1927-28, No. 2, pp. 49-70.

The displacement of a bundle of light resulting from two plane reflections is the equivalent of a "swing" of the emergent part of the bundle round the line of intersection of the two reflecting faces. Prisms can be designed by considering pairs of reflections. Graphical work for the directions of the axial ray and the disposition of the field round that ray can be worked out by means of a spherical diagram from which sufficient information can be derived to facilitate the construction of models (a) of the path of the axial ray and (b) of the full bundle of light.

From the second model (b) constructed reasonably to scale a wooden model of the prisms can be built up. The angles between faces of the prism can be computed accurately from the spherical diagram.

The method is particularly applicable to "skew" prisms in which three successive parts of the axial ray do not lie in a plane.

Binocular prism-systems are dealt with in some detail.—M.B.R.

The "Absolute" Hartman Test. R. Kingslake, Trans. Opt. Soc., 1927-28, No. 3, pp. 133-141.

According to the ordinary methods of performing the Hartmann test, the assumption is made that all the rays cross the optical axis. As a matter of fact, this is very far from the truth, especially in the case of the large astronomical objectives and mirrors to which the Hartmann test is most generally applied. In the present paper a brief description is given of a modified test in which each "ray" is treated on its own merits and its absolute deviation from the ideal path is determined in both magnitude and direction. This method incidentally leads at once to the well-known criterion "T" of Hartmann, which is now generally adopted in the comparison of large telescopes.—M.B.R.

An Investigation into the Beam from a Standard Lighthouse Lens. W. M. Hampton, Trans. Opt. Soc., 1927, No. 3, pp. 101-132.

The distribution of light from a third order Fresnel panel was measured, using two different light sources, a standard petroleum vapour burner and a 3 kw. lighthouse cruciform lamp.

A complete theoretical discussion of the factors affecting beam candle-powers is worked out and tables are provided for the calculation of the beam candle-power from any apparatus using any light source.—M.B.R.

Tachometer. Wilhelm Morell. Zeits. V.D.I. May 19, 1928, pp. 684.

New type of tachometer, novel range changing device. Description, photographs and sketches.—G.B.K.

Determination of the orientation of Aluminum Crystals Optically. (Bestimmung der Orientierung von Aluminumeizelkrestallen auf optischem Wege.) J. Weerts, Zeits, tech. phys., April 1928, p. 126.

New instrument to determine the crystal orientation of aluminum, by use of polarized light. Description of instrument and of data obtained.—G.B.K.

Surveyor's Instruments and Equipment. William A. Ehrman. Bulletin No. 19 Engineering Extension Department of Purdue University.

The uses of the transit, the level and steel tapes is briefly discussed.—M.B.R.

The Design of Polarising Prisms by Graphical Methods. J. H. Dowell. Instrument World, June 1928, pp. 37-39.

The design is briefly described.—M.B.R.

Standardisation in Apparatus for Science Teaching. Instrument World, June 1928, pp. 45-46.

Abstract of a paper read before the Royal Society of Arts by William Taylor. Instruments for use in physics laboratories are taken up.—M.B.R.

A New Method of Spectorscopy for Faint X-Radiations. P. A. Ross, Jl. Opt. Soc. June 1928, pp. 433-437.

The method here described seems to have a field of usefulness where faint sources are to be dealt with. It may enable the investigator to deal with radiations more than a thousand times fainter than could be analyzed by the crystal method.—M.B.R.

The Thomas Recording Gas Calorimeter. Technical Paper No. 20. Department Scientific and Industrial Research.

The report contains a short description of the instrument and a full account of the various tests carried out, and the conclusions reached. These show that, if properly installed and adjusted, and given reasonable care in maintenance, the instrument should give a reading, when working on a gas of steady calorific value, correct to 1 B.T.U.—M.B.R.

Temperature Radiation. W. E. Forsythe, Jl. Opt. Soc., May 1928, pp. 307-328.

The work carried out on temperature radiation is reviewed.—M.B.R.

Some Experiments on Geiger Ion Counters. R. D. Berrett, Jl. Opt. Soc., May 1928, pp. 339-354.

With the purpose of extending the usefulness and reliability of the Grieger iron counter an investigation of its behavior under widely varying conditions was undertaken, including the effect of size of point and chamber, position of point in chamber, effect of voltage on sensitivity, effect of nature and pressure of gas used, sensitivity to ultraviolet light, sensitivity to ion of small energy, effect of various properties of the electrical circuits, and an investigation of the time lag in its action.—M.B.R.

Focusing Electrons Reflected or Emitted at Equal Angles from a Plane Surface. D. A. Wells, Jl. Opt. Soc., May 1928, pp. 355-356.

A method is proposed and the theory briefly given for focusing to a line all electrons of the same energy reflected or emitted at any given angle from a plane surface.—M.B.R.

A Projection Electroscope for Standardizing Radium Preparations. L. F. Curtiss, Jl. Opt. Soc., May 1928, pp. 363-366.

This electroscope devised by the Bureau of Standards is illustrated and described.—M.B.R.

Some Further Uses for the Neon Grid-Glow Tube. T. R. Wilkins and F. B. Friend, Jl. Opt. Soc., May 1928, pp. 370-373.

Two applications of the three-electrode neon tube are described. The first shows how the neon tube can be used for the registration of alpha rays. One electrode of an ionization chamber is connected to the grid of the neon tube and the tube flashes on the entrance of each alpha ray. In the second device, the tube is arranged to flash periodically and it is found that under certain critical conditions, a bias potential of a volt or two has a marked and easily measurable effect on the periodicity of discharge.—M.B.R.

The "Ultramicrometer," a New Instrument for Measuring Very Small Displacement or Motion, and its Various Applications. Juichi Obate, Jl. Opt. Soc., June 1928, pp. 419-429.

In this article, the detailed construction and various examples of applications of the "ultramicrometer," a new instrument for measuring a small displacement or motion utilizing a generating valve circuit, are described. The displacement or motion to be measured is made to produce either a change in the capacity of the circuit or a change in eddy current loss, and in consequence a corresponding change in the anode current of the valve results. This change in the anode current is measured with a galvanometer, or if a permanent record is required, an Einthoven string galvonometer or a Duddell oscillograph is used. The anode current itself is balanced by means of a potentiometer method, or a small transformer is inserted in the anode circuit.

As examples of the applications of this instrument are described the recording of earth movements, direct recording of accelerations, an electrical indicator for high speed internal combustion engines, precise recording of sounds, pressure variations and various mechanical vibrations.

On Gustiness of Winds. T. Terada, M. Tamans and K. Nisida. Report No. 38 of the Aeronautical Research Institute, Tokyo Imperial University, June 1928, pp. 235-270.

Records were made of winds by means of a Dines' type anemograph and an automatic recording wind vane. The results are given in this paper.—M.B.R.

Giving Scales a Variety of Jobs. Scientific American, August 1928, pp. 119.

Some uses of scales are illustrated.—M.B.R.

Review of Recent Patents

Printed copies may be obtained at the cost of 10 cents by addressing the Commissioner of Patents, Washington, D. C.

THERMAL REGULATOR. Harlan S. Gano, Wilkinsburg, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,675,340.

MEANS FOR MEASURING BALANCE OF ELECTRICAL NETWORKS. Summer B. Wright, So. Orange, N. J., assignor to American Telephone & Telegraph Co. Pat. No. 1,675,441.

THERMOMETER. Henry B. Brown, Rochester, N. Y., assignor to Taylor Instrument Companies. Pat. No. 1,675,531.

LIQUID LEVEL INDICATOR. John A. Dieuner, Chicago, Ill., assignor to Stromberg Motor Device Co. Pat. No. 1,675,698.

METER-OPERATING MEANS. Garrison Babcock, Everett, Wash. Pat. No. 1,675,919.

SPEED INDICATING DEVICE. Piero Gambarotta, Quiteto al Mare, Italy. Pat. No. 1,675,974.

MICROMETER GAUGE. William L. Bryant, Springfield, Vt. Pat. No. 1,676,248.

LIQUID-QUANTITY-INDICATING DEVICE. Alphons Dittlinger, Emil V. Dittlinger, Jr., and Nicholas Dittlinger, St. Louis, Mo. Pat. No. 1,676,255.

UNIT MEASURING MACHINE. Christian N. Bergmann, Pittsburgh, Pa., assignor to Bergmann Packing Machine Co. Pat. No. 1,676,377.

CLOCK MEASURING MACHINE. Anthony Vanderveld, Grand Rapids, Mich., assignor of one-half to Harry B. Parrish, Grand Rapids, Mich. Pat. No. 1,676,587.

RECORDING APPARATUS. August N. E. Boos, New York, N. Y. Pat. No. 1,676,629.

GAS METER. Arno R. Huettig, Stratford, Conn., assignor to American Meter Co. Pat. No. 1,676,651.

GAUGING INSTRUMENT. Frederick W. Stalker, Rochester, N. Y., assignor to Taylor Instrument Companies. Pat. No. 1,676,673.

GAUGE WITH A PRECISION INDICATOR FOR TESTING THE FLANK DIAMETER OF EXTERNAL THREADS. Max Bartholdy, Essen, Germany, assignor to Fred Krupp Aktiengesellschaft. Pat. No. 1,676,721.

DEVICE FOR CALCULATING TIME. Frederick C. Meacham, Garden City, N. Y. Pat. No. 1,676,912.

GROUND-SPEED INDICATOR. Herbert O. Russell, Detroit, Mich., and Charles Leigh Paulus, Dayton, Ohio. Pat. No. 1,676,965.

BAROMETRIC DEVICE. Ivan I. Eremeeff, Dayton, Ohio. Pat. No. 1,676,983.

REFLECTOMETER. Frank A. Benford, Schenectady, N. Y., assignor to General Electric Co. Pat. No. 1,677,014.

COMPENSATED METER. Arthur G. Grier, Peterboro, Canada, assignor to General Electric Co. Pat. No. 1,677,025.

GAS MEASURING. Elmer I. McKesson, Toledo, Ohio. Pat. No. 1,677,147.

PHOTOELECTRIC CELL. Vladimir K. Zworykin, Wilkinsburg, Pa., assignor to Westinghouse Elect. & Mfg. Co. Pat. No. 1,677,316.

TEMPERATURE TIME-CONTROL DEVICE. August J. Mottlan, Pittsburgh, Pa., assignor to Westinghouse Elect. & Mfg. Co. Pat. No. 1,677,361.

GAUGE. Gerald H. Allen, Detroit, Mich. Pat. No. 1,677,424.

GASOMETER. Konrad Jagschitz, Maniz, Germany, assignor to Maschinenfabrik Augsburg, Nuernberg, A. G. Pat. No. 1,677,524.

FREQUENCY-RESPONSIVE INSTRUMENT. Francis B. Vodges, Schenectady, N. Y., assignor to General Electric Co. Pat. No. 1,677,694.

TEMPERATURE REGULATOR. Alfred Daniker, Zurich, Switzerland. Pat. No. 1,677,710.

HYDROMETER. Frank E. Sode, Chicago, Ill. Pat. No. 1,677,801.

METER. Garrett B. Linderman, Jr., Bethlehem, Pa., assignor to American Meter Co. Pat. No. 1,677,834.

METER. Garrett B. Linderman, Jr., Erie, Pa., assignor to American Meter Co. Pat. No. 1,677,835.

METHOD AND APPARATUS FOR MEASURING DISTANCE. Robt. Longfellow Williams, Newton, Mass., assignor to Submarine Signal Corp. Pat. No. 1,677,943.

FLUID PRESSURE CONTROL DEVICE. Joseph G. Fay, Seattle, Wash. Pat. No. 1,677,961.

SPEEDOMETER. Percy A. Robbins, Highland Park, Ill. Pat. No. 1,677,990.

STRAIGHT LINE INDICATING MECHANISM. Joseph Leopold, New York, N. Y., assignor to Consolidated Instrument Co. of America. Pat. No. 1,678,009.

FLEX-TESTING MACHINE. Thomas Midgley, Hampden, Mass., assignor to Fisk Rubber Company. Pat. No. 1,678,017.

RESISTANCE CONTROL APPARATUS. Henry J. Weigand, Milwaukee, Wis., assignor to The Cutler-Hammer Mfg. Co. Pat. No. 1,678,028.

MICROMETER CALIPER. Horace J. Youndt, Indianapolis, Ind. Pat. No. 1,678,030.

APPARATUS FOR TESTING ABRASION RESISTANCE. Frank A. Fahrenwald, Chicago, Ill. Pat. No. 1,678,110.

MEASURING AND RECORDING MACHINE. Leon A. Durgin, Danvers, Mass. Pat. No. 1,678,181.

OIL THERMOMETER. Arthur Holmes, Newark, N. J., assignor to The Holmes Automobile Co. Pat. No. 1,678,389.

Draft Control an Important Item. Ind. Power, Feb. 1928, pp. 74-76.

Installation of a draft controller in a laundry is described.—M.B.R.

Determining Short Wave Paths. H. T. Früs, Bell Laboratories Record, June 1928, pp. 359-362.

The apparatus and method of determining the direction of reception is described.—M.B.R.

Geophysical Prospecting for Oil Resources. Oil Engineering and Technology, May 1928, pp. 153.

The gravity gradiometer is briefly described.—M.B.R.

A Shielded Bridge for the Measurement of Induction in Terms of Resistance and Capacity. B. W. Bartlett, Jl. Opt. Soc., June 1928, pp. 409-418.

This paper describes a bridge evolved from that devised by Owen and extended by Ferguson. It may be completely shielded without undue constructional difficulties and is capable of high accuracy at both speech and carrier frequencies. It also differs from the Owen bridge in that it measures parallel rather than series inductance.—M.B.R.

The Determination of the Error of the Axis and the Testing Respectively Correction of Reversing Levels. (Ueber die Bestimmung des Kippachsenfehlers und die Pruefung bzw. Berichtigung von Reversionslibellen). V. Theimer, Zeits. Instrumentenk, July 1928, pp. 327-338.

The article discusses the determination of the axis error with a level fastened to the axis, the testing respectively the correction of double section levels, and the use of collective levers with distance measuring telescopes.

The Conversion of Inclined Measured Lengths to the Horizontal in Ground Line Measurements With Wires. (Die Umrechnung von schief gemessenen Laengen auf die Horizontale bei Grundlineenmessung mit Draehten). P. Werkmeister, Zeits. Instrumentenk, July 1928, pp. 338-339.

The calculation is illustrated.

Integration by Means of the Curvimeter. (Integration virmittels des Kurvimeters). H. Schwerdtfeger, Zeits. Instrumentenk, July 1928, pp. 340-344.

The method is illustrated.

The Thomas Calculating Machine and their development in Germany. (Die Thomasmachinen und Ihre Entwicklung in Deutschland). K. Wolter, Zeits. f. Feih Mechanik, June 29, 1928, pp. 1-4.

The historical development is briefly mentioned. The design of the machine is described and illustrated.

Laboratory Measurement of Capacity, Power Factor, Dielectric Constant, Inductance and Resistance by Use of the Series Resistance Bridge. C. L. Lyons, Jl. Scient. Insts., June 1928, pp. 188-194.

Continued from May issue, page 160. This installment takes up measurement of power factor or phase angle, dielectric constant, resistance and inductance.—M.B.R.

Temperature Measurements in Research on Air-cooled Internal Combustion Engines. J. F. Alcock, Jl. Scient. Instr., June 1928, pp. 177-183.

Thermocouples used on air-cooled cylinders of gasoline engines are apt to be very inaccurate, owing to the cooling effect on the leads of the high speed air blast used to cool the cylinders. Measurements were therefore made of the errors occurring with various couples in common use, also with a type of couple specially designed to reduce the error to a minimum.—M.B.R.

The Photometer Bench. John F. Sutton, Jl. Scient. Instr., June 1928, pp. 184-187.

The author reviews the various types of photometer benches on the market and criticises them from the point of view of accurate experimental work, pointing out the lack of features which are essential when making measurements with any degree of precision.

The various essential adjustments and readings in obtaining a photometric comparison are enumerated and are followed by a list of the methods available for carrying out the adjustments. A design is then given of a photometer bench, which incorporates all the above features and which has been found to be suitable for the accurate comparison of all kinds of lamps.—M.B.R.

Fluid Governors for Prime Movers. Henry Schmidt, Elect. Jl., July 1928, pp. 354-358.

The discussion of operating mechanisms is continued.

Tests with the Oscillograph to Determine the Procedure in Electric Arc Welding. (Versuche mit dem Oszillographen zur Erforschung der Vorgaenge im elektrischen Schweisslichbogen). K. Bung. E.u. M. Wien. May 27, 1928, pp. 490-495.

On a basis of oscillograms the electric relation of the various dynamos and transformers in welding is shown.

New Tests with X-rays in the Welding Science. (Neueste Versuche mit Roentgenstrahlen in der Schweisstechnik). I. Kanter. E. u. M. Wien. May 27, 1928, pp. 495-509.

The use of the X-ray investigation in general, and especially the X-ray investigation of welds is taken up. The modern instruments and devices are discussed.

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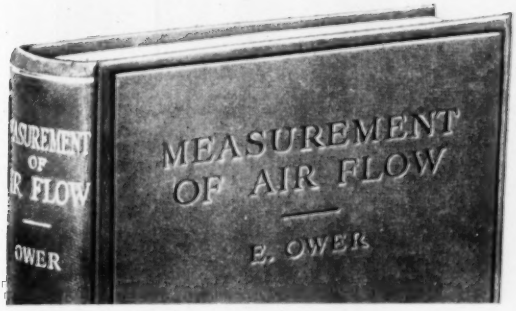

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D. L. PARKHURST, INSTRUMENTS, Vol. 1, No. 8, pp. 347-350, 2 figs.

The design of the Geodetic Level Rod is taken up and the provisions for leveling, reducing the effect of temperature changes, swelling of the wood, temperature determination, and elimination of error due to sagging are discussed.

The old method of graduating the rod is mentioned. A new graduating machine developed by the Instrument Division, U. S. Coast and Geodetic Survey is then described.

MEASUREMENT OF TEMPERATURES IN BOILER FURNACES

J. A. STEIN, INSTRUMENTS, Vol. 1, No. 8, pp. 351-353.

The various pyrometric devices available for the measurement of boiler furnace temperature are briefly discussed and their limitations mentioned.

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DR. JOSEPH EUGENE ROWE, INSTRUMENTS, Vol. 1, No. 8, pp. 355-357.

A new calculating instrument which has the following applications is described: simplification of computations in surveying; basis for automatic surveying instruments; range-finding for artillery on land and at sea; enable an aircraft to locate itself and to aid in teaching mathematics. Examples illustrating the use of the instrument are given.

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JAMES S. MARTIN, INSTRUMENTS, Vol. 1, No. 8, pp. 359-370, 11 figs.

Reprint of a lecture given before the fourth annual meter school at the Carnegie Institute of Technology. The function of instrument transformers is given and the difficulties to be overcome are taken up with the methods of overcoming these difficulties.

A NEW TURBIDIMETER

DR. W. EWALD, INSTRUMENTS, Vol. 1, No. 8, pp. 371-375, 2 figs.

The instrument and its construction is briefly described.

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